Development and Validation of a Screening Tool for Specific Learning Disability in School Going Children in Rural Tamil Nadu

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY FOR DEGREE OF M.D. BRANCH XV (COMMUNITY MEDICINE) EXAMINATION TO BE HELD IN MARCH 2009.

CERTIFICATE

This is to certify that the dissertation titled **"Development and Validation of a Screening Tool for Specific Learning Disability in School Going Children in Rural Tamil Nadu"** is a bonafide work of Dr.Tanya Seshadri in partial fulfillment of the requirements for M.D. branch XV (Community Medicine) Examination to be held in March 2009.

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COMMON ABBREVIATIONS USED

SLD	Specific Learning Disability
DSM IV-TR	Diagnostic and Statistical Manual of Mental Disorders IV edition Text revision
UNESCO	United Nations Educational, Scientific and Cultural Organization
WEI	World Education Indicators
SSA	Sarva Shiksha Abhiyan
EFA	Education For All
MDG	Millennium Development Goals
USA	United States of America
MR	Mental Retardation
IQ	Intelligence Quotient
ICD 10	International Classification of Diseases 10^{th} edition
ROC	Receiver operator characteristic
PPV	Positive Predictive value
NPV	Negative Predictive value
LR	Likelihood ratio
ABL	Activity Based Learning
BKT	Binet-Kamat Test
CAP	Department of Child and Adolescent Psychiatry
SPSS	Statistical Package for Social Sciences
PU	Panchayat Union
STARD	Standards for Reporting of Diagnostic Accuracy
HIV	Human Immunodeficiency Virus
AIDS	Acquired Immune Deficiency Syndrome

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1. INTRODUCTION AND JUSTIFICATION

Education is considered to be a vital instrument that has the ability to empower an individual. However, it is often forgotten that education is one of the strongest predictors of health.[1] Education has been recognized to be the most powerful instrument at hand to reduce poverty and inequality and to lay the basis for sustained economic growth and sound governance.[2,3]

Primary education is considered to be the gateway to all higher levels of education. It develops the capacity to learn, to read and use math, to learn information and to apply it. The lack of primary education therefore constrains the potential of not only the individual but also that of the society he/she belongs to. The achievement of universal primary school completion hence becomes a topic of national interest.

Universal completion unlike universal access cannot be achieved without ensuring improvement in the schooling quality, students' learning progress, and household demand for education - all of which are interlinked.[2] This requires school systems to allocate resources so that special support is provided to slower learners, children with physical or emotional disabilities, or children for whom consistent school attendance is jeopardized by poverty or family health crises.[4]

India has made great progress in expanding the formal schooling system and in improving enrolments in the primary school. However, the retention rates and achievement level of students continue to be at very low levels.[5] Hence, the focus is shifting from equity in access to equity in achievement.[6]

There are many states like Tamil Nadu which have already achieved almost universal primary enrolment[5] and they need to focus on programmes to improve the retention rates and levels of learner achievement.

Learning Disability has been emerging in the recent years as an important factor that affects a child's academic potential. These are life-long and pervasive. They affect every aspect of a child's life which becomes more woven into their personality and career options as they grow up.

Though initially it seems to affect their academic life only, it spills onto their family life as well, slowly hampering their social interactions and limiting their employment opportunities as they grow up. The stress from all this leaves them with low self esteem and keeps them as unmotivated and poor achievers in the long run.[7]

A comprehensive assessment is the ideal method but with an estimated prevalence of one in ten children having some form of learning disability, purely speaking in numbers the resources needed to accurately diagnose every child in the schooling system alone can be unimaginable even if one considers India alone, let alone the world. To restrict numbers and still identify those with highest probability, simpler methods are needed which are easy to apply and do not cause a big dent in our limited resources. This is why screening children for learning disabilities becomes a vital issue. The widely recommended screening method is through Early Identification Programs and is best conducted at school level.[8]

Few screening tests have been designed in India.[9,10,11,12] These however remain fraught with many controversies. Those comparable to international tools are in English which is not the primary language in most parts of India, particularly in rural India. Those created in native tongues have not been validated and hence, research done with their aid, though essential, can be questioned.

Through this study we have attempted to formulate a simple screening method that can be applied at the Elementary school level. With the aid of this tool, children with learning disabilities would be identified early on and hence, through appropriate

remedial intervention would be able to avail all opportunities to lead a socially and economically productive life.

Three great men, Sir Winston Churchill, Thomas Edison and Albert Einstein had one thing in common. Sir Winston Churchill, former Prime Minister of England, as a child was a slow learner and suspected to have dyslexia.[13] Thomas Edison, a great inventor, had limited formal schooling and apart from his hearing impairment was suspected to have multiple learning disabilities.[14] Albert Einstein, the man who gave us the General theory of relativity, could not talk till the age of three and was not fluent in his native language even by nine.[15] They all had Specific Learning Disability. This leads us to wonder how many great men and women in India have not been allowed to achieve all that they can due to our ignorance in this subject.

2. OBJECTIVES

Objective

To develop, validate and apply a screening tool for learning disability among school children in rural Tamil Nadu.

Specific Objectives

1. To develop a screening tool to detect Specific Learning Disability (SLD) in children studying in the second grade in Tamil medium schools in Tamil Nadu
2. To validate this tool using Diagnostic and Statistical Manual of Mental Disorders Fourth edition Text revision (DSM IV-TR) criteria as the Reference Standard.
3. To estimate the prevalence of SLD in children studying in second grade across a rural block using this screening tool.

3. LITERATURE REVIEW

The significance of learning disability and its burden as a public health issue can be gauged in the context of hurdles faced in enabling universal primary education which is one of the Millennium Development Goals. Investment in primary education has been associated with economic growth particularly in developing countries as detailed below.[2] Growth in economic output in turn provides the resources for tackling poverty, social exclusion and poor health.[16] The convergence of globalization, knowledge driven economies, human rights based development and demographic trends has led to the recognition of the vital role of education in countries across the globe.[3]

3.1 Education

3.1.1 Importance

The foundation of education is laid in the early years via the formation of intelligence, personality and social behavior. It is then that learning occurs faster than at any other time and patterns are established that have far-reaching implications.[17] Hence, adequate attention is a must to a child's learning in the early years, while also making vital contributions to improving key education indicators and quality in primary schools through impacts on children, parents, and teachers.[17]

There are many studies which have dealt with recognizing the significance of investing in the early years. High returns have been reported – in terms of educational gains, health status and economic productivity. Studies by the World Bank and other organizations in Bolivia, Colombia, Egypt and the United States have found returns of around 3:1 (as high as 7:1) – which also make for a very powerful economic argument.[17]

3.1.2 International "Education For All' Goals

Table 1. International goals highlighting the importance of universal education

DAKAR WORLD EDUCATION FORUM GOALS	MILLENNIUM DEVELOPMENT GOALS
Expand and improve comprehensive early childhood care and education, especially for the most vulnerable and disadvantaged children.	
Ensure that by 2015 all children, particularly girls, children in difficult circumstances, and those belonging to ethnic minorities, have access to and complete free and compulsory primary education of good quality.	Goal 2: Achieve universal primary education. Target 3: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling.
Ensure that the learning needs of young people and adults are met through equitable access to appropriate learning and life skills programs.	
Achieve a 50% improvement in levels of adult literacy by 2015, especially for women, and equitable access to basic and continuing education for all adults.	Goal 3: Promote gender equality and empower women. Target 4: Eliminate gender disparity in primary and secondary education, preferably by 2005, and at all levels of education no later than 2015.
Eliminate gender disparities in primary and secondary education by 2005, and achieve gender equality in education by 2015, with a focus on ensuring girls' full and equal access to and achievement in basic education of good quality.	
Improve all aspects of the quality of education and ensure excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy, and essential life skills.	

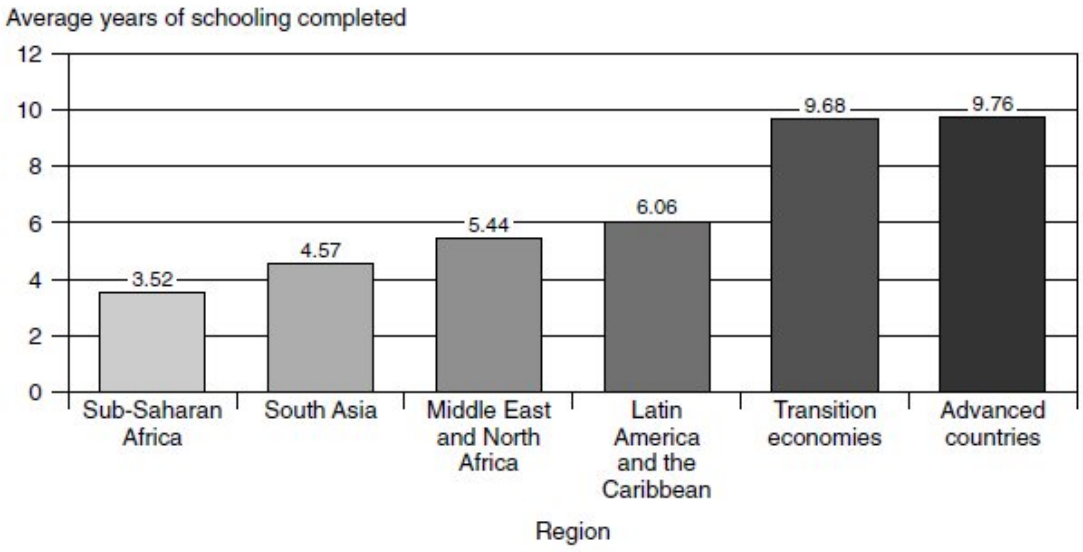
Source: Bruns B et al 2003 p25[2]

3.2 Primary education

3.2.1 Importance

Extending adequate quality primary education to vulnerable groups like girls, ethnic minorities, orphans, people with disabilities, and people living in rural areas is vital to enable them to contribute to and benefit from economic growth.[2] Microeconomic research has established unequivocally that education improves individual incomes. Economic studies on Human Capital and Growth have shown an impact of education on economic growth and they report a positive association.[2] A high rate of return (around 30%) to investment in primary education is due to the fact that one-third of the labour workforce is illiterate in most developing countries, hence there is a big payoff at the margin when someone completes primary education.[18] Number of years of schooling has been associated with overall development of the country. This has been shown in the following table.

Fig 1. Average education attainment of adult population shown by region in 2000



Source: Bruns B et al. 2003.p27[2]

The countries participating in the UNESCO World Education Indicators (WEI) programme have realized that educational attainment is not only vital to the economic well-being of individuals but also for that of nations. Access to and completion of education have been the key determinants in the accumulation of human capital and economic growth. From the results in WEI countries, it can be said that for every single year the average level of schooling of the adult population is raised, there is a corresponding increase of 3.7 per cent in the long-term economic growth rate.[3]

Primary education has also been shown to contribute to better natural resource management and better technological adaptation.[2] In high seroprevalence countries, the children at primary school level have been called the "Window of hope" and appropriate education at this level helps in equipping them with knowledge and the power to reduce the rates of infection in these nations.[18,19] Hence, achieving the goal of universal primary education will also have strong effects on achievement of the other millennium goals and ensure better economic development of the nation.

3.2.2 Sarva Shiksha Abhiyan (SSA)

The Sarva Shiksha Abhiyan is a landmark strategy towards achieving the goal of UEE in partnership with State. It aims to provide useful and quality elementary education to all children in the 6 -14 age group by 2010.[5]

Objectives:

1) All children in school, education guarantee centre, alternate school, ' to School' camp by 2003;
2) All children complete 5 years of primary schooling by 2007;
3) All children complete 8 years of schooling by 2010;

4) Focus on elementary education of satisfactory quality with emphasis on education for life;
5) Bridge all gender and social category gaps at primary stage by 2007 and at elementary education level by 2010;
6) Universal retention by 2010.[5]

SSA lays a special emphasis on making education at elementary level useful and relevant for children by improving the curriculum, child centered activities mid effective teaching methods.

3.2.3 Situation in India

Universal Elementary Education is a Constitutional provision and a national commitment now converted to the "Education For All" strategy in India.[20]

- The literacy rate in the 2001 Census has been noted to be 65.3%.
- 95% of children in the age-group of 6-11 years are enrolled in primary schools
- The primary enrollment rate remains high at 95% with states like Tamil Nadu boasting of 97% second only to Kerala.
- 60% of children in the age group of 11-14 years are enrolled in higher primary schools.
- 59 million children (about 33%) in the 6-14 years age group are out of school.
- Drop out rate (2001-02) up to class V is 40% and up to class VIII is 55%.
- The average Tenth board results across the country are around 45% which implies 55% students fail.[20]

3.2.4 School enrollment

To achieve EFA goal for universal primary education, focus has been on enrolling children into schools and not on school completion rates or learning outcomes.[2] The Net Enrollment Ratio has also been proposed to be the main indicator for the MDG. This has been considered to be an unrealistic goal as this does not represent the true picture of primary school completion.[2] When looking closely at the countries for Organization for Economic Cooperation and Development, of 155 developing countries, about half have enough primary schools already to educate 100% of their primary school-aged children. However when considering 100% primary school completion rate, only 37 of those countries have achieved that today.[2]

Another indicator is hence needed to give us a clear idea of the situation in primary schools today and this is the Primary Completion Rate. The primary completion rate is calculated as the total number of students successfully completing the last year of primary school in a given year, divided by the total number of children of official graduation age in the population. The primary completion rate in India has increased over the last decade from an estimated 70% in 1990s to 76% in early 2000, which is definite progress. However if this trend continues in India at the same pace (around 0.9% per year) then in 2015 it would still stand at 90% still far from achieving EFA.[16]

Government policies have made the schools accessible and hence, increased enrollments. This is no doubt the first step towards increasing academic achievement. However, due to limited resources, school conditions and learning achievement have begun to suffer. Schools have developed a "quantity-quality tradeoff" in the process.[6] Hence, the onus shifts to the school system to train its teachers in devising innovative teaching strategies to meet the child's learning needs.[1]

3.2.5 Learning outcomes in India

Many recent papers studying the achievement levels of children in elementary schools have shown low levels of achievement in language and mathematics assessed at the terminal class of primary school.

- Achievement at class I is reasonably high, but there is a sharp decline in the performance of class IV children.[21,22]
- Rural – urban variation was looked for but not found in some while in others, no consistent pattern was seen.[22, 23]
- No significant difference in the overall performance of girls and boys in achievement level was seen in most studies unlike that seen at higher classes.
- A wide variation in mean percentage of achievement scores was found between different states. States like Bihar and Rajasthan have higher achievement scores compared to educationally forward as found in certain studies.[24] One explanation for this is that enrolment is much higher and drop out is lower in the latter states. Thus in the former case the mean scores are of the academically better off children, while in the latter it represents the average achievement of the student population. But that does not make the situation any more comforting.

In Tamil Nadu which boasts of an enrollment rate of 97%, a "learning quality crisis" has been described.[25]

- 50% children in 5th standard cannot read a paragraph in Tamil.
- 10% children in 5th standard cannot even identify letters.
- 50% children in 5th standard cannot even subtract two 2-digit numbers.
- Even 4-year-olds in balwadis cannot match two identical pictures.

3.3 School Dropouts

3.3.1 Importance of school completion

It has been estimated that globally around 113 million children do not attend primary school of which as much as one quarter belong to India.[16]

The Gross Enrolment Ratio at the Primary stage has exceeded 100%. But from 200 million children in the age group of 6 - 14 years, 59 million children are not attending school. Of this, 35 million are girls and 24 million are boys. This has been attributed to dropouts, low levels of learning achievement and low participation of girls, tribals and other disadvantaged groups.[26]

The SSA Phase I reports 1999 in Tamil Nadu give a disturbing picture.[27]

- 17.6% students dropped out in five years from various Grades.
- The second important finding is that of all children retained in the school for five years, as many as 28.5% could not reach Grade 5, a large proportion of them repeated at least once in five years.
- The third aspect relates to the completion rate. Not all children reaching Grade 5 passed the final examination successfully. Only 91.7% children reaching Grade 5 passed the final examination.

3.3.2 Factors responsible for dropouts

National Dropout Prevention Center and Network USA have identified factors responsible for dropouts at 3 levels.[1,28,29]

Table 2. Factors responsible for dropouts in school children

Individual or Family	Community	School or School System
• Low family socioeconomic status • Racial or ethnic group • Male • Special education status • Low family support for education • Low parental educational attainment • Residential mobility • Low social conformity • Behaviors such as disruptive conduct, truancy, absenteeism, and lateness • Being held back in school • Poor academic achievement, • Academic problems in early grades • Not liking school • Feelings of "not fitting in" and of not belonging • Perceptions of unfair or harsh • Feeling unsafe in school • Not engaged in school • Being suspended or expelled • Having to work or support family • Substance use • Pregnancy disciplines	• Living in a low-income neighborhood • Having peers with low educational aspirations • Having friends or siblings who are dropouts	• Low socioeconomic status of school population • High level of racial or ethnic segregation of students between schools in a district or within tracks or classes in a building • High proportion of students of color in school • High proportion of students enrolled in special education • Location in central city • Large school district • School safety and disciplinary policies • High-stakes testing • High student-to-teacher ratios • Academic tracking • Discrepancy between the racial or ethnic composition of students and faculty • Lack of programs and support for transition into high school for 9th and 10th graders

A paper published in the Economic and Political Weekly (December 23-29, 2006), which is based on a survey of school dropouts in and around Guwahati, Assam found

that the variable 'cared for doing well in studies' was the most important determinant for dropping out of school.[28] The survey discovered that those who did not care much for doing well in studies were 7.7 times more likely to drop out than those who did. Also, the likelihood of dropping out, in such circumstances, increased by 2.7 times as a student moved from primary school to a higher stage.

3.3.3 Consequences of dropping out from school[1,28,29]

- Dropouts are more likely to be unemployed
- They earn less money when they eventually secure work.
- They usually work at unskilled jobs
- They aim at low-paying service occupations

3.4 Learning disability

3.4.1 Definition: Given below is the definition recommended by the National Joint Committee on Learning Disabilities, USA.1982.p945-7.[30]

'Learning disabilities is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction."

"Even though a learning disability may occur concomitantly with other handicapping conditions (e.g., sensory impairment, mental retardation, social and emotional disturbance) or environmental influences (e.g., cultural differences, insufficient / inappropriate instruction, psychogenic factors), it is not the direct result of those conditions or influences.'

The true prevalence of Learning Disability is subject to much controversy due to the lack of an agreement on a universal definition with an objective set of identification criteria. Some researchers have argued that a 5% prevalence rate is inflated; while others debate that a majority of SLD is still underdetected.[7]

3.4.2 Causes of Learning Disabilities

- **Genetic factors**[1,32] – Positive Family history of SLD is a strong indicator of the possibility of hereditary component of some subtle brain dysfunction
- **Factors related to pregnancy**[1,32] – Any early disruption to the fetal brain commonly leads to abortions or a grossly malformed baby with possible mental retardations. Late disruptions are believed to cause more subtle errors in the cell framework which may manifest in later life as learning disabilities.
    - Tobacco, Alcohol, and Other Drug Use – The damaging effects of drug intake during pregnancy is well known. This may be direct or indirect.
        - Indirect – Smoking during pregnancy is known to cause smaller babies – low birth weight has been associated with greater probability of SLD.
        - Direct – Alcohol / Drug abuse like cocaine during pregnancy have been known to damage fetal brain cells and receptors which may be manifested later on as SLD.
    - Perinatal factors
        - Birth asphyxia
        - Low birth weight / preterm babies
        - Hypoxic damage in early neonatal period due to seizures / kernicterus / sepsis

- **Environmental factors**[1,32]
    - An alternative explanation to family history suggested is that it may arise from the family environment. A hypothesis suggested is limited language exposure in home or at childcare.
    - Strangely a higher incidence has also been noted in adopted children.
    - Exposure to toxins – Cadmium (present in some steel products) and lead (commonly in paint and petroleum products) have been associated with neurological damage which may become permanent on prolonged exposure.
    - Exposure to radiation / Chemotherapy at a young age – usually therapeutic.

3.4.3 Types

Learning disorders can be divided into four basic categories depending on the four stages in the learning process:

1. Input[33]

Here the sensory information is received through the senses, perceived and then interpreted to mean something.

- Difficulties with perception if visual can cause problems with recognizing the shape and size of items seen.
- Difficulties with temporal perception i.e. difficulties with processing time intervals can cause problems with sequencing.
- Difficulties with perception if auditory can cause problems in focusing on one sound while ignoring background or competing sounds like the sound of other children in the class while the teacher talks.

2. Memory[33]

Here information learnt afresh is connected to that already learnt or stored. There are 2 types of memory known - short-term memory, or long-term memory.

Difficulties can arise with either type most commonly with the former. In such cases, more repetitions are required to learn new information.

3. Integration[33]

Here the information already perceived is used or stored for later use. To enable this, the input is sequenced or categorized or related to other already learnt information.

Difficulties with integration can cause problems in sequencing information for instance parts of a story may come apart when told in the wrong order, or days of the week may be recited in the wrong order.

4. Output[33]

Information once perceived, stored and interpreted is verbalized through words or by action that is through language or gestures or drawing.

Difficulties with language output can cause problems with spoken language or with written language. For instance to answer a simple question, a child must retrieve information from memory, organize his thoughts, and put them into words before he speaks or writes. Difficulties with motor abilities can cause problems with gross and fine motor skills. Children may become clumsy or might have problems with learning to ride a bicycle or with handwriting.

3.4.4 Clinical features

Learning disorders are often not very obvious but can be detected by observing delays in the child's skill development. A 2-year delay in the primary grades is usually considered significant.[1]

In young children, errors or misuse of words or sounds is a normal part of learning. Its only when these problems persist when one should be concerned, usually beyond a period of 6 months.

- Difficulties in writing - repeated spelling mistakes, untidy or illegible handwriting with poor sequencing.[12]
- Difficulties in mathematics - inability to perform simple mathematical calculations, confusing numbers with one other.[12]
- Difficulties in reading - slow, laborious, skipping words, guessing words.[12]

3.4.5 Impact

Children with SLD fail to achieve school grades at a level that is expected at their intelligence. If not managed early on, it can lead to poor school performance and even school drop-out.[20,34]

The main reason behind the child's failure comes from the behaviour of their peers, parents and most importantly teachers. The impact will vary from child to child, depending on many factors:[35] These include:

- the severity of the underlying problems
- the individual pattern of difficulties
- how early the learning disability was identified
- how early appropriate support was given
- the personal characteristics of the individual involved
- the strategies used
- the support which is available from the school, family and friends.

Children with learning disabilities are more likely to exhibit increased levels of anxiety, withdrawal, depression, and low self-esteem compared with their nondisabled peers. This comparison and hence, these conditions are persistent.[36] A study on SLD and Attention Deficit Hyperactivity Disorder in Mumbai used a criterion-referenced test based on the state education board curriculum for diagnosing SLD. It showed that there was a delay in diagnosis of SLD, which resulted in children having poor school performance in spite of having normal intelligence. Many children also experienced class retention and developed behavioral problems.[12] In many instances, it appears that such emotional problems reflect adjustment difficulties resulting from academic failure. Deficits in social skills have also been found to exist at higher rates among children with learning disabilities. This includes lack of knowledge of how to greet people, how to make friends, or how to engage in playground games.[7]

Long-term consequences of this disability remaining undetected include an increased risk for developing substance abuse addiction and psychiatric disorders such as anxiety disorder or depression.[34]

3.4.6 Diagnosis – Resources / Cost

Actual diagnosis, however, can only be made using standardized tests that compare the child's level of ability to what is considered normal development for that age and intelligence. A multidisciplinary team comprising of pediatrician, counselor, clinical psychologist and special educator are needed before the diagnosis of SLD can be confirmed.[11,20,37] Audiometric and ophthalmic examinations need to be done to rule out non-correctable hearing and visual deficits as these deficits can be the root of their problems and hence causing the apparent learning disability. Such children do not qualify to be diagnosed as SLD. Children detected to have obvious MR (IQ<70) also do

not qualify. Debates are on as to include or exclude those with Borderline intelligence (IQ – 70 to 85). Today the diagnosis needs a multidisciplinary approach as explained earlier but primarily needs to be confirmed by a psychiatrist by ascertaining that the child's specific behaviors meets the Diagnostic and statistical manual of mental disorders IV Text revised (DSM IV-TR) criteria or the ICD 10 criteria laid by WHO.

Scholastic Learning disabilities can be divided into three broad categories as mentioned in the manual of DSM IV-TR criteria 2000.[39] These are: (ICD 10 codes also provided)

1. Reading disorder (commonly called Dyslexia)
2. Mathematics disorder (commonly called Dyscalculia)
3. Disorder of Written Expression (commonly called Dysgraphia)

1. **Diagnostic criteria for Reading disorder** (DSM IV-TR 315.00 and ICD-10 F81.0)

A. Reading achievement, as measured by individually administered standardized tests of reading accuracy or comprehension, is substantially below that expected given the person's chronological age, measured intelligence, and age-appropriate education.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require reading skills.

C. If a sensory deficit is present, the reading difficulties are in excess of those usually associated with it.

2. **Diagnostic criteria for Mathematics Disorder** (DSM IV-TR 315.1 and ICD 10 F81.2-3)

A. Mathematical ability, as measured by individually administered standardized tests, is substantially below that expected given the person's chronological age, measured intelligence, and age-appropriate education.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require mathematical ability.

C. If a sensory deficit is present, the difficulties in mathematical ability are in excess of those usually associated with it.

3. **Diagnostic criteria for Disorder of Written Expression** (DSM IV-TR 315.2 and ICD-10 F81.1)

A. Writing skills, as measured by individually administered standardized tests (or functional assessments of writing skills), are substantially below those expected given the person's chronological age, measured intelligence, and age-appropriate education.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require the composition of written texts (e.g., writing grammatically correct sentences and organized paragraphs).

C. If a sensory deficit is present, the difficulties in writing skills are in excess of those usually associated with it.

3.4.7 Screening as the first option

The widely recommended method is through Early Identification Programs and best conducted at school level. The goal of such programs is to identify children who can potentially have handicapping conditions.[8] This can be done at many levels namely, at preschool level, primary level or even at the level of 10^{th} std. These programs are usually an integrated approach which combines detection of at-risk indicators, systematic observations, validated screening tests and other procedures.

An effective identification program must also take into account the biological and environmental factors as listed earlier that could influence a child's development.[8]

Once a child is detected to have a problem, then they must undergo comprehensive and detailed assessment and must also be periodically followed up to monitor their progress.

- **At-Risk Indicators**[8]

It is commonly known that there are various factors that have been associated with poor developmental outcome as listed earlier. Some can be used as indicators to identify a child at-risk for developing learning disabilities. For instance, children with a history of prenatal or perinatal exposure. This is usually used as an aid in young children at preschool or early primary level or when such history is available.

- **Systematic Observations**[8]

These observations should provide a detailed description of the problem identified. When behavior is noticed that is believed to be deviated from normal for that child, the family must be notified immediately and the child referred to a professional for evaluation. This is an essential activity if effective planning and implementation of appropriate treatment is to occur.

- **Screening Tests and Other Procedures**[8]

Many screening tests are available from written self administered tests to teacher rating tools. Most studies use locally developed tools even though international validated tools are readily available. All children who have been identified via screening i.e. who are suspected of having a SLD must be referred to professionals for assessment, evaluation, and follow-up services so as to identify and manage the specific patterns of abilities and disabilities in the children.

A useful test for identifying learning disabilities in children in primary school has been developed by the Child and Adolescent Mental Health unit, National Institute of Mental Health Neuro Sciences; Bangalore is useful in the assessment of 1 to standard 5. The areas that are assessed include attention, language, reading, comprehension, spelling, writing, dictation, visual-motor integration, visual memory, auditory memory and arithmetic ability.

Curriculum-based assessments is a recommended method of diagnosing SLD.[11,12,37,38] For instance, a locally developed criterion referenced test based on the Maharashtra Education Board curriculum is used to detect SLD in schools across Maharashtra. This includes assessment in specific areas of learning like basic learning skills, reading comprehension, etc.

3.4.8 Management

Management of SLD needs a lifelong perspective. Early on, the cornerstone of treatment is remedial education. As a child matures and enters the more time-demanding setting of secondary school, the emphasis shifts to the important role of providing accommodations.[34]

The intervention needs to begin early, when the child is in primary school or even earlier in preschool if resources are available. The longer children with SLD go without identification, the more difficult the task of remediation and the lower the rate of success.[12]

Early remedial education can be accomplished with systematic and highly structured training exercises, such as identifying rhyming and non-rhyming word pairs, blending isolated sounds to form a word, or conversely, segmenting a spoken word into its individual sounds.[34] The management in the setting of secondary school is based more on providing provisions (accommodations) rather than remediation. These provisions like exemption from spelling mistakes, availing extra 30 minutes for all written tests, dropping a language and substituting it with work experience, dropping algebra and geometry and substituting them with lower grade of mathematics and work experience, are meant to help the child cope up in a regular mainstream school.[40]

- The first and foremost method is to create awareness of this hidden disability amongst teachers, doctors and also increase awareness for the general public.[41] It has been shown that a supportive home environment can favour better outcomes in a child with SLD.
- Secondly, the opportunities to get involved must be provided to counselors and special educators by encouraging universities to start B.Ed and M.Ed courses for special education.
- Third and the most important learning disability needs its recognition as a disability by the Government of India and be included under the Persons with Disabilities Act 1995.[41]

3.4.9 Other research done at international level

There is much debate about the prevalence of SLD across the world. This primarily due to the controversies behind accepting a universal definition or criteria to diagnose SLD.[7] Still the prevalence in developed countries range between 5-15%. Almost 10% of school going children have specific learning disability in the form of dyslexia, dysgraphia and or dyscalculia in USA.[20,34] Dyslexia (or specific reading disability) affects 80% of all those identified as learning-disabled.[34] The incidence of dyslexia in school children in USA ranges between 5.3- 11.8%.[42]

Few reasons used to explain the apparent increase in prevalence in the last few decades are better research, a broader definition of learning disability and greater focus in identification of difficulties faced by girls in school. Few reasons cited against these are using vague definitions of learning disability, financial incentives to identify students for special education, and inadequate preparation of teachers leading to over referral of students with any type of special need.[7]

3.4.10 Other research done in India

A study done on child and adolescent psychological morbidity in Bangalore showed that a sizeable proportion of children (9.4%) had scholastic problems. This suggests that the needs of children with scholastic underachievement must be addressed, despite the lack of a psychiatric diagnosis.[43] The incidence of dyslexia in primary school children in India has been reported to be 2-18%, of dysgraphia 14%, and of dyscalculia 5.5%.[9,10,44] The Central Board of Secondary Education has already recognized dyslexia as a disability that can affect a child's education. States like Maharashtra have also provided academic provisions for children certified by psychiatrists to have SLD. A study to show the impact of these provisions has shown that all children availing these provisions in tenth standard not only passed in their first attempt but also most scored above 60%.[11] However, these provisions are not available to many children with SLD in other states, particularly those who are studying in vernacular medium schools, for non-availability of standardized psychological and educational tests .when they assessed the impact of remedial education on those children, only 10% received this as for most it was too late as they were diagnosed at standard VIII to X and hence would not have benefitted from it.[11]

In a recent study carried out at a Learning Disability clinic in Mumbai, there was an increase of 22% in the mean total marks obtained by children with SLD who availed provisions at the Secondary School Certificate examination. Their mean total marks increased from 43% before diagnosis of SLD to 65% after availing provisions. Improved academic outcome also resulted in increased confidence and self-esteem in these children.[40]

The Achievement Surveys on Quality Education conducted by the Tamil Nadu State Project Directorate showed a mean learning achievement of 53.9% at Grade 3 (Rural 57.7%).[5] Another Achievement Survey by the National Council of Educational Research and Training showed that Tamil Nadu students crossed 60% mark in achievement in Mathematics and 70% achievement level in language at Grade 5. An Achievement survey conducted on Reading Skill for Grade 5 students in Namakkal District showed that only 56% of children have satisfactory reading skill. A survey in Tamil Nadu in 2006 showed that of children in 1st to 8th standard that were surveyed, only 14.6% children in the district could do simple division, 32.1% could do subtraction and 86% could recognize numbers. 13.9% children could not even recognize numbers. This shows an urgent need for an intervention in reading and maths.[25] Such figures put the light on the true issues we are faced with today in Tamil Nadu. The answer lies in educational reform programmes.

Tamil Nadu is one of the frontline States in India in implementation of the Sarva Shiksha Abhiyan programme (Anaivarukkum Kalvi Thittam). Several initiatives have been undertaken and successfully carried through during the current year with the project entering the eighth year of implementation. Today the SSA has risen to the challenge and has adopted a multifaceted approach. They plan to rehabilitate dropouts and on recruiting special teacher-educators to cope with the concern of the increasing number of disabled children. But with poor awareness in the community and an extremely large population to handle, the situation in India remains unique in comparison to other countries. With the introduction of Activity Based Learning and Active Learning Methodology at Elementary level in Tamil Nadu education has become child-centered, joyful and participatory. Quality in education is given major priority in the 2008-2009 Annual Plan. New approaches to active pedagogical learning and innovative modalities are to be

developed to ensure all the children acquire the desired competencies. Remedial teaching for the learning disabled has been seen to play an important role here in their academic achievement.[4]

In Vellore alone, around 38,816 children have been estimated to have learning problems. This includes around 22,336 children in elementary schools both Government and Aided (a total of 2,53,536 children) and around 16,480 children in middle schools (a total of 1,86,211 children). In Tamil Nadu, a total of 5,91,140 children have been estimated to need remedial intervention in the next academic year.[4]

3.5 Study designs

3.5.1 Diagnostic Accuracy Study

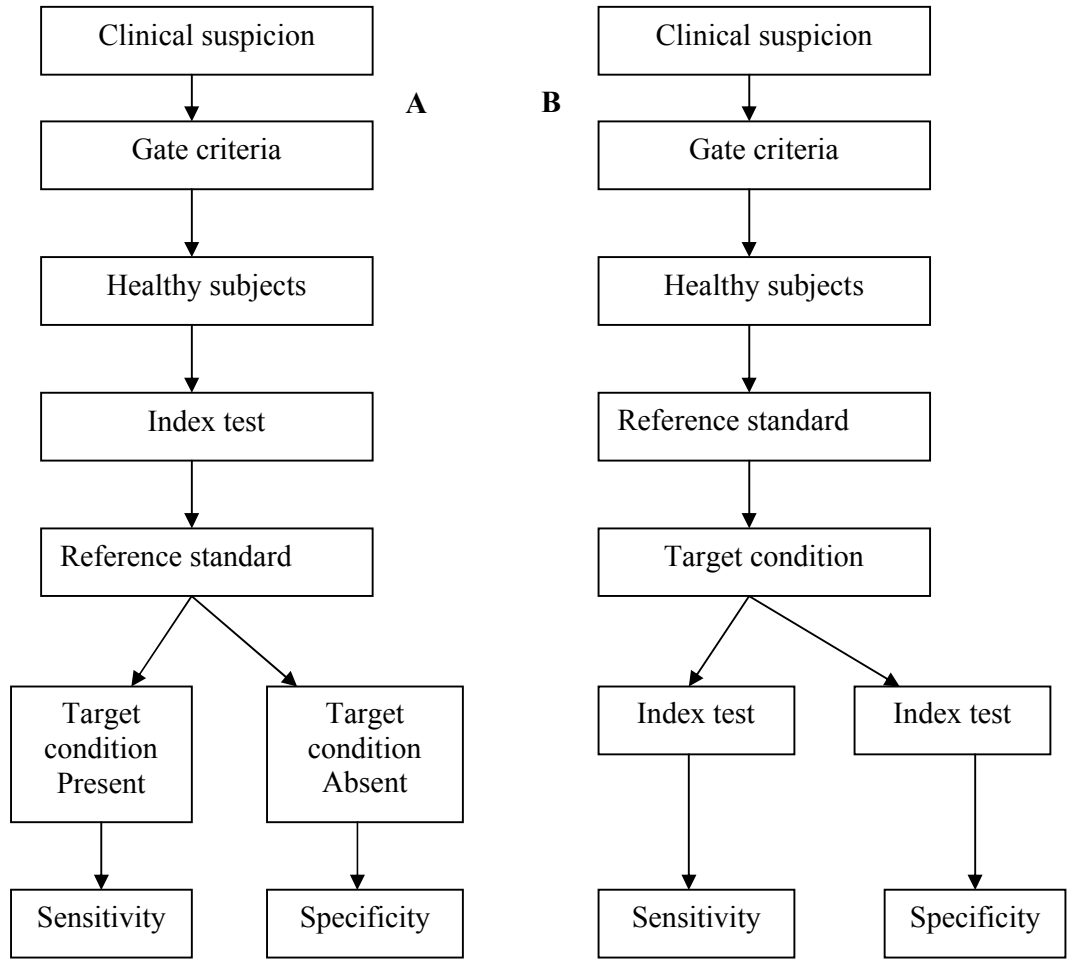
In a study for diagnostic accuracy. the outcomes from one or more tests under evaluation are compared with outcomes from the reference standard, both measured in subjects who are suspected of having the condition of interest.

Important Terms[45]

- **Test:** any method for obtaining additional information on a patient's health status. For e.g.: information from history and physical examination, laboratory tests, imaging tests, etc
- **Target condition:** a disease or any other identifiable condition that may prompt clinical actions, such as further diagnostic testing, or the initiation, modification or termination of treatment.
- **Reference standard:** the best available method for establishing the presence or absence of the condition of interest. It can be a single method, or a combination of methods, to establish the presence of the target condition.

- **Accuracy:** the amount of agreement between the information from the test under evaluation, referred to as the index test, and the reference standard.

Design - Fig 2. A. Classical design B. Reverse flow design



Source: Rutjes AWS et al.2005.[46]

Types[47]

a) **Qualitative:** Patients here are classified diseased or disease-free according to the presence or absence of a clinical sign or symptom

b) **Quantitative:** Patients are classified as diseased or disease-free on the basis of whether they fall above or below a preselected cut-off point which is also referred to as the critical value

Outcome[34,47]

Diagnostic accuracy can be expressed in many ways, including sensitivity and specificity, likelihood ratios, diagnostic odds ratio, and the area under a Receiver Operator Characteristic (ROC) curve. First a simple 2x2 table is created.

Table 3. Comparing results of a test against reality

		Disease		**Total**
		Positive	**Negative**	
Test	**Positive**	a True Positives	B False Positives	Total positive
	Negative	c False Negatives	D True Negatives	Total negative
Total		Total with disease	Total without disease	Total population screened

- **Sensitivity** is the proportion of patients with disease whose tests are positive.

Sensitivity = $\frac{a}{(a+c)}$. Highest sensitivity is desired when:

  - The disease is serious and should not be missed.
  - The disease is treatable.
  - False Positive results do not lead to serious physical, psychological or economic consequences to the patient.

- **Specificity** is the proportion of patients without disease whose tests are negative.

Specificity = $\frac{d}{(b+d)}$. Highest Specificity is desired when:

  - The disease is not treatable or curable.
  - False Negative results do not lead to serious physical, psychological or economic consequences to the patient.

- **Positive Predictive value of a test (PPV)** is the proportion of patients with positive tests who have disease. This measures how well the test rules in the disease. It is the posttest probability of a disease given a positive test.

$$\text{PPV} = \frac{a}{(a+b)}$$

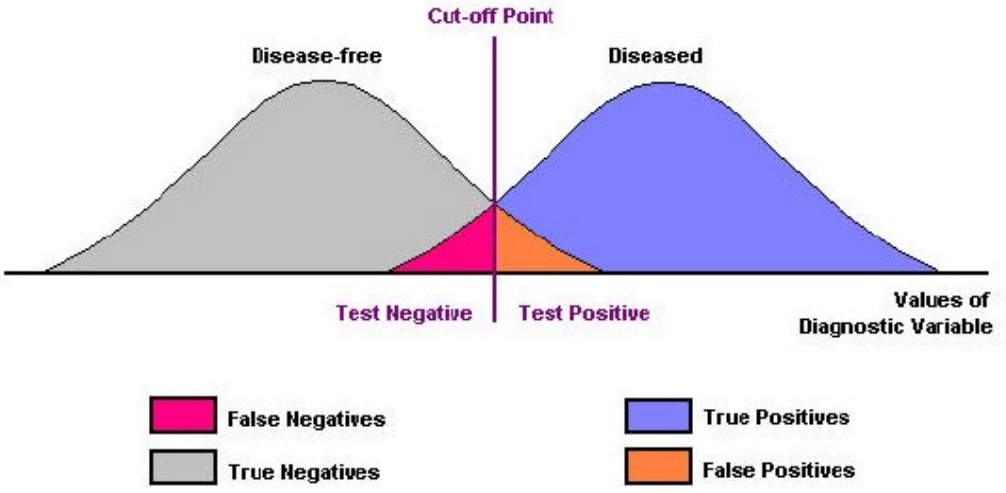
- **Negative Predictive value of a test (NPV)** is the proportion of patients with negative tests who do not have disease. This measures how well the test rules out the disease.

$$\text{NPV} = \frac{d}{(c+d)}$$

- **Likelihood ratio (LR)** in favour of a test is the ratio of the posttest probability to the pretest probability. It can also be expressed in terms of the sensitivity and specificity of the given test.

$$\text{LR} = \frac{Sensitivity}{(1 - Specificity)}$$

Fig 3. Gaussian curve representation of test results



Source: Ertasg G.1993.[47] Left curve represents normal individuals while the right curve represents diseased individuals. The cutoff point is the point that is associated with minimum false positives and false negatives.

Limitations

The main limitation of such a design comes from chances if variability. Reasons for variability have been enumerated below:

1) **Between test types or readers**[49] **-** Data should be presented on the variability between different readers or types of test and on tools to help calibration. The extent to which other factors, such as experience or training, affect reading adequacy is also helpful.
2) **Between subgroups of the study population**[49] **-** Data on individuals should be available for determining the influence on test performance of the following variables: the spectrum of disease and no disease, the effect of other test results, logical sequencing of tests, and any other characteristics that could influence test performance.
3) **Between settings**[49] **-** Test performance needs to be compared in several populations or centers. Variability between settings can also be explored across different studies by using Meta analytic techniques.

The most widely recognized disadvantage of previous studies is poor reporting. A survey of studies of diagnostic accuracy published in four major medical journals between 1978 and 1993 revealed that the methodological quality was mediocre at best evaluations were hampered because many reports lacked information on key elements of design, conduct and analysis of diagnostic studies.[50] The objective of the Standards for Reporting of Diagnostic Accuracy (STARD) initiative is to improve the quality of reporting of studies of diagnostic accuracy The purpose of the STARD initiative is to improve the quality of the reporting of diagnostic studies.[45]

3.6 Analysis

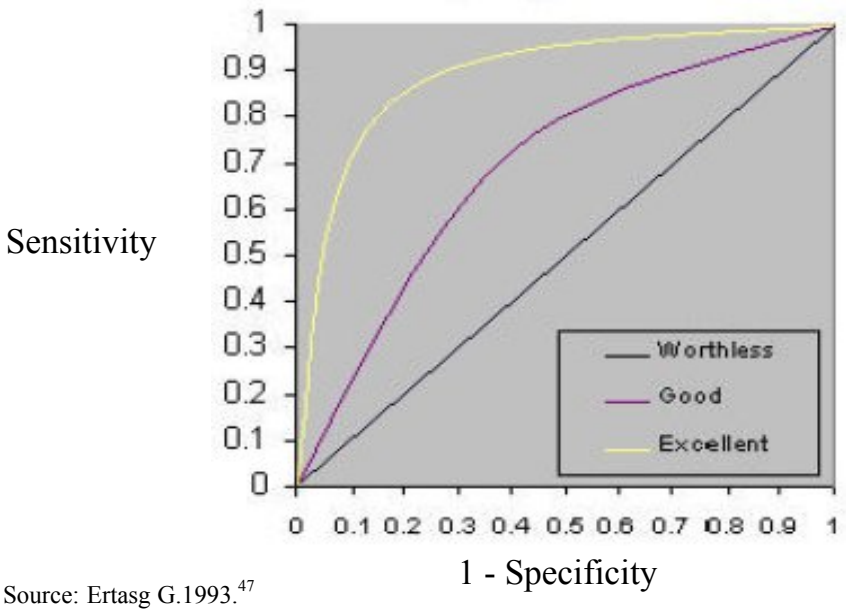
3.6.1 Receiver Operating Characteristics (ROC) curves

ROC analysis is part of a field called "Signal Detection Theory" developed during World War II for the analysis of radar images. This is the standard approach to evaluate the accuracy of diagnostic procedures.[47,48]

Each point on the ROC curve:

- is associated with a specific diagnostic criterion.
- shows the tradeoff between sensitivity and specificity
- The closer the curve follows the left-hand border and then the top border of the ROC space, the more accurate the test.
- The closer the curve comes to the 45-degree diagonal of the ROC space, the less accurate the test.
- The slope of the tangent line at a cut-point gives the likelihood ratio (LR) for that value of the test.
- The area under the curve is a measure of test accuracy.[47,48]

Fig 4. ROC curves with varying area under the curves



Source: Ertasg G.1993.[47]

An area under the curve of

- 0.90-1.0 = Excellent
- 0.80-0.90 = Good
- 0.70-0.80 = Fair
- 0.60-0.70 = Poor
- 0.50-0.60 = Failure

Uses

- Measuring test accuracy by calculating the area under the curve.
- Comparing two tests by comparing the shapes of their corresponding curves
- Choosing a suitable threshold or cut-off point for a test. A point near to the upper left corner is usually chosen. It represents the balance between sensitivity and specificity.

3.6.2 Reliability

A test is reliable to the extent that whatever it is supposed to measure, it measures it consistently.[51] Reliability is the correlation of an item, scale, or instrument with a hypothetical one which truly measures what it is supposed to. It does not imply validity. This implies that a reliable measure measures test consistently, but need not necessarily gauge how the test measures what it is supposed to be measuring Reliability is inversely related to random error.[52] It is the correlation of an item, scale, or instrument with a hypothetical one which truly measures what it is supposed to.

Types:

- **Inter-rater Reliability**[51, 52] **-** Two raters can evaluate a group of students by the same test and the correlation between their ratings can be calculated (r = 0.90 is a common cutoff).

- **Percentage Agreement**[51,52] – Two raters can evaluate a group of students by the same test and a percentage for the number of times they agree (outcomes) is calculated (80% is a common cutoff)
- **Test-Retest Reliability**[51,52] **-** The same test is given twice to the same group of students. The reliability is the correlation between the scores on the two tests. If the results are consistent over time, the scores should be similar. The deciding factor is the duration between the two tests. One should wait long enough so the subjects don't remember how they responded the first time they completed the instrument, but not so long that their knowledge of the material being measured has changed. This may be a couple weeks to a couple months.

Limitations[51]

- **Test Taker** - the student could be having a bad day because he does poorly when the test is repeated
- **Test Itself** - the questions on the test may be unclear, thereby the student only guesses answers
- **Testing Conditions** - there may be distractions during the test that do not allow the student to focus on the test
- **Test Scoring** - Raters may be applying different standards when evaluating the students' responses. This can be overcome by standardizing the test and the method of scoring.

3.6.3 Bayes' Theorem

This is a theorem attributed to Thomas Bayes (1702-61) and it provides the means to derive the conditional probability of a positive test for a certain disease from the conditional probability of the diseases for a patient given a positive test.[48]

Given below is another way of representing the 2x2 table described earlier in Table 3.

Table 4. Classification of subjects given their diseases status and test results

		Disease		**Total**
		Positive (D+)	**Negative (D-)**	
Test	**Positive (T+)**	a True Positives	B False Positives	Total positive
	Negative (T-)	c False Negatives	D True Negatives	Total negative
Total		Total with disease	Total without disease	Total population screened

- Sensitivity = P (T+/D+)
- Specificity = P (T-/D-)

- $PPV = P(D+/T+) = \dfrac{P(D+) \cdot P(T+/D+)}{P(D+) \cdot P(T+/D+) + P(D-) \cdot P(T+/D-)}$

- $NPV = P(D-/T-) = \dfrac{P(D-) \cdot P(T-/D-)}{P(D-) \cdot P(T-/D-) + P(D+) \cdot P(T-/D+)}$

4. MATERIALS & METHODS

The overall study had 4 main components:

4.1 Development of the screening tool for SLD

4.2 Cross sectional study involving application of the screening tool developed

4.3 Testing the validity and reliability of the screening tool

4.4 Analysis

4.1 Development of the Screening tool

The first step was to study in detail the syllabus being used for second grade children in government schools in the study area.

- **Activity Based Learning (ABL)** – As this is the method of teaching in Primary schools in Tamil Nadu, this methodology was looked at closely.
- **Second grade syllabus**- This was studied in detail with respect to its objectives and the skills that were expected to be developed at the second grade level. This was done again by discussions with school teachers and by going through the curriculum guide provided under the SSA scheme to teachers.
- **Learning difficulties** – Since the tool had to be created keeping in mind the errors expected in second grade children, the school teachers' opinions were sought in this matter with particular reference to language i.e. Tamil and Mathematics.

The second step was to create the screening tool for SLD. Tools used to identify SLD were reviewed through literature. This included international tools and those used in India. These tools were looked at with reference to their design, items included, scoring

patterns and their application in the community. Since the review of literature revealed that no such screening tools existed which could be applied to this population, the tool was developed along with experts in the field of Child Psychiatry with experience in the field of Psychometrics.

The following steps were carried out in developing the tool:

- **Item identification**

Items were listed for each skill that a child at second grade level was expected to have. This was based on information already gathered as mentioned earlier and via literature review.

- **Item construction**

For each skill/ item listed, questions were carefully selected by going through their syllabus and from information provided by teachers. The type of questions to be framed was a vital issue discussed since the existing method of assessment in schools for this age group only included fill in the blanks. In order to keep the tool interesting for children and so as to incorporate all stages of learning, each question was designed individually and this enabled the tool to be versatile.

- **Item wording**

Each question was worded in simple spoken Tamil language. Similar questions from syllabus were looked at and used as the basis for this. They were framed directly in Tamil and did not involve translation from English to Tamil. After the tool was formulated, it was again reviewed by Tamil speakers and teachers and the wording was further simplified.

- **Item paneling**

The sequence of the questions for each of the three sections started with basic questions and moved on to more difficult ones. An important reason for this was to build confidence in the children as they answered them.

- **Preliminary tool**

The tool had been developed in 3 sections – Reading, Writing and Mathematics. The preliminary tool contained 25 items framed with multiple questions under each in each section. This was reviewed by second grade teachers and their comments were noted. This was also put to test in a few children in a Government school that was not included in the study and the performance of each item was reviewed and keeping the teachers' comments in mind, minor modifications were made. .

- **Final SLD tool**

The final tool which was applied to the children in the study had 21 items in the following sections:

- Reading – 6 questions
- Writing – 4 questions
- Mathematics – 11 questions

4.2 Cross Sectional study involving application of the Screening tool developed

4.2.1 Study Setting

The study was conducted across Government and Aided Schools – both Elementary and Middle schools across Kaniyambadi block in Vellore District. The Community Health and Development (CHAD) Programme of Christian Medical College (CMC) Vellore, has been providing primary and secondary care to over 1 lakh people residing in this block for the last 50 yrs. During this period, many small and large scale studies have

been conducted in schools of this block. This has led to formation of a close relationship and deep understanding of the benefits from research and training, not only among the school administration but also among the residents of this block.

Clearance was first obtained from the Institutional Review Board and the Ethics Committee of Christian Medical College (CMC) Vellore, following which permission was obtained from the District Elementary Education Office

4.2.2 Study duration

October 2007 to September 2008

4.2.3 Target population

The target population included children studying at the Second grade level in Government and Aided Elementary and Middle schools across Kaniyambadi block. The District Survey in 2005 obtained from the District Education Office, Vellore, estimated the total number of children studying at Second grade level alone in this block to be 1635 children.

4.2.4 Sample size

The sample size calculation was based on the expected ability of the tool to detect children with learning disability. The aim was to achieve a sensitivity of 90% with a precision of 10%.

$$n = \frac{4pq}{d^2} = \frac{4 \times 0.10 \times 0.90}{(0.10)^2} = \frac{0.36}{0.01} =$$ 36 children with learning disability

where p = Sensitivity = 0.90

q = (1 – p) = 0.10

d = absolute precision = 0.10

Estimating a prevalence of 15% based on the literature[9,10,44] to detect 36 children with learning disability, 240 children needed to be screened. Thus, the sample size was 240 children.

4.2.5 Sampling Method

The list of schools was obtained from the District Education Office. From this list, schools were selected by random sampling and it was decided to study all children from the selected schools. The schools were listed in order of priority and after the exact number of children in these schools was obtained from the school registers, the first 11 schools obtained by random sampling were selected with a total of 264 children.

4.2.6 Exclusion Criteria

- Children in the 2nd grade who had not completed 6 years yet.
- Children with an IQ less than 70.

4.2.7 IQ Test

The widely used Binet-Kamat Test (BKT) was selected to test the IQ of the children. One of the exclusion criteria was children with IQ less than 70 as this implied severe Mental Retardation. This was done to avoid overlapping cognitive affective disorders as much as possible. Children with Borderline IQ were included. This decision was made by looking at other tools used globally and after discussing with child psychiatrist. Estimation of the IQ of children not being an objective and it merely being an eligibility criteria, the section of BKT used evaluate IQ for 6-8 yr olds alone was used. No score was calculated. The primary reasons for this were that the process did not serve any role in the study intended and was time consuming

4.2.8 Selection of Investigators

- **IQ test** – This was conducted by the Primary Investigator – a post graduate student in community medicine who was trained at the Department of Child and Adolescent Psychiatry to conduct the Binet-Kamat Test.
- **SLD Tool** – This was applied by a social worker who was involved with development of the tool and trained in application of the same. To ensure that the results would not have changed if a teacher had been used instead of the social worker, the inter-rater reliability was tested using a primary school teacher.
- **DSM IV TR Criteria** – Child psychiatrists working at the Department of Child and Adolescent Psychiatry (CAP) applied this to children selected. The performance of the children in the screening tool was not informed to the psychiatrists in order to avoid bias.

4.2.9 Application of the screening SLD tool

School administrations were first contacted and the consent forms were distributed across the 11 schools chosen to 259 children. Any query that arose from a parent, guardian or school was solved face to face or via phone and the study explained. A total of 259 children participated in the study and were subjected to the modified BKT for eligibility. This was done in the school itself. The index SLD tool was then applied by the social worker. This was also done in the school premises itself. This was applied to 234 children only as the others had failed to meet the eligibility criteria. The schools were approached in a sequential order. Both tools were applied over a period of 4 months and the interval between the two was limited to a maximum of 4-6 weeks.

4.3 Testing the Validity and Reliability of the Screening tool

4.3.1 Validity

DSM IV-TR criteria along with ICD 10 criteria are the standard tools used internationally to identify SLD in children. The DSM IV-TR criteria was the reference standard that was used to diagnose SLD in this study. The DSM IV-TR criteria was administered by a child psychiatrist at the Department of Child and Adolescent Psychiatry itself.

Ideally, all children screened by the screening SLD tool should have been subjected to the Reference standard. However, due to constraints of time, manpower and finances, it was decided that only a third of the children would be subjected to further diagnosis.

Methodology:

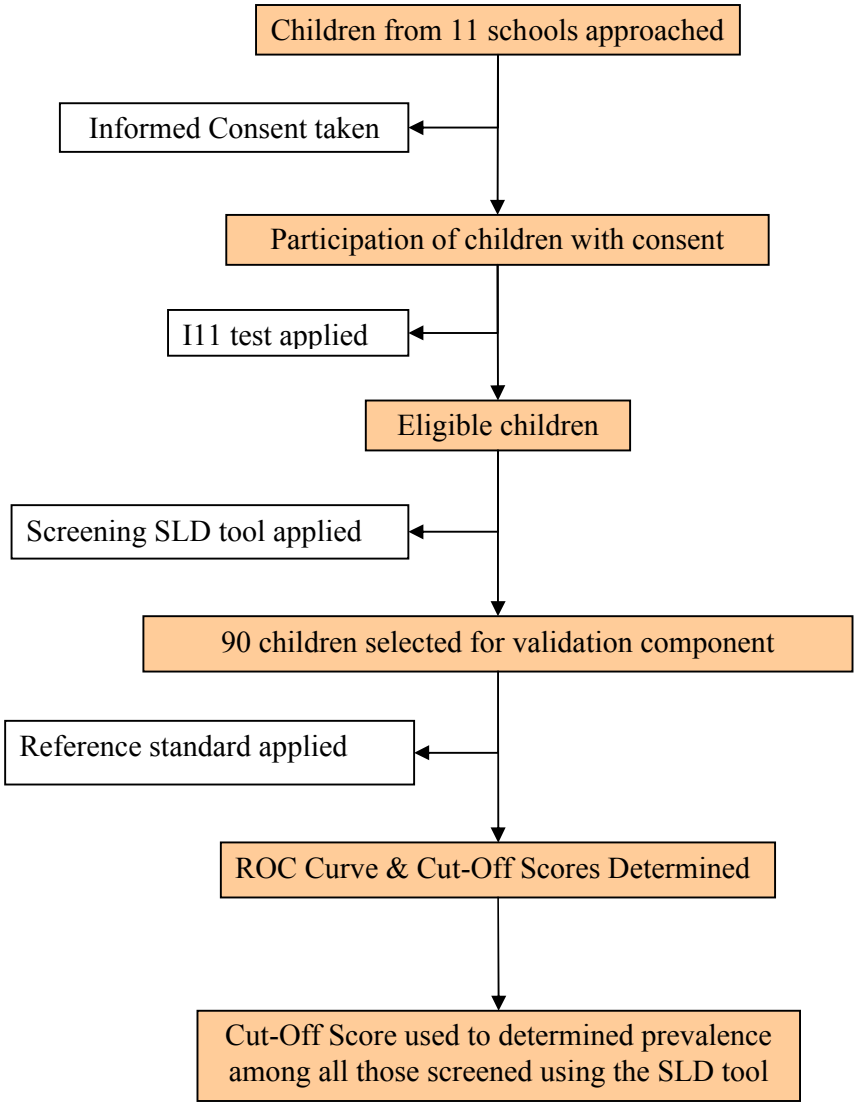
The investigating team selected a third of the children screened. This number was rounded off to 90. These children were selected based on their performance in the screening SLD tool.

- 35 children with the lowest scores
- 35 children with the highest scores
- 20 children were randomly selected from the mid range

The parents of the selected children were contacted and consent was retaken verbally. They were then requested to bring their children to the Department of Child and Adolescent Psychiatry. The children were seen by the psychiatrists in random order and their performance in the screening SLD tool was not revealed to avoid any bias on the part of the evaluator.

The presence or absence of SLD was noted and if present, then its specific type was diagnosed and the guardian counseled appropriately. Presence of other cognitive affective disorders was also noted to enable the child for detailed evaluation later.

Fig 5. Outline of the Study Methodology



4.3.2 Reliability testing

- **Inter-Rater Reliability testing**

An independent investigator was selected for this purpose. An experienced teacher was trained to use the SLD tool and she applied this to 7 (9% of 78) children. The results were compared to the results of the social worker.

- **Test-retest reliability testing**

The social worker who applied the Screening SLD tool initially retested 13 (17% of 78) children. The results were compared to that of their earlier test.

4.4 Analysis

4.4.1 Data Entry

Data Entry and analysis was done using SPSS v12.0.

4.4.2 Receiver Operator Characteristic (ROC) Curve and Validation

The results for the 78 children who were subjected to the reference standard were acquired. Next a Receiver Operation Characteristic (ROC) curve was created with the scores from the Screening SLD tool against their reference standard results. This was done to check the ability of the tool to discriminate children with SLD from those who did not have SLD. A cut-off point for their SLD tool score was arrived at keeping the desired sensitivity and specificity in mind.

Using the cut-off point, the children were divided into 2 groups – test positive and test negative. Test positive implied a high suspicion of SLD according to the Screening tool and vice versa for test negative. Using this data, the 2x2 table was created. Predictive values and Likelihood ratio were calculated.

4.4.3 Prevalence estimation

The cut-off point decided by the ROC curve, divided the 259 children into 2 groups – test positive and test negative. The prevalence of SLD as detected by the Screening SLD tool was estimated.

$$\text{Prevalence} = \frac{(p + Specificity) - 1}{(Sensitivity + Specificity) - 1}$$

where p = proportion of test positives in the screened population

This formula was derived using Bayes' Theorem.

$$P(T+) = P(T+/D+) \,.\, P(D+) + P(T+/D-) \,.\, P(D-)$$

$$= P(T+/D+) \,.\, P(D+) + P(T+/D-) \,.\, [\, 1 - P(D+) \,]$$

$$= P(T+/D+) \,.\, P(D+) + P(T+/D-) - [\, P(T+/D-) \,.\, P(D+) \,]$$

Hence,

$$P(T+) = P(T+/D-) + P(D+) \,.\, [\, P(T+/D+) - P(T+/D-) \,]$$

$$P(T+) - P(T+/D-) = P(D+) \,.\, [\, P(T+/D+) - P(T+/D-) \,]$$

Reversing the equation,

$$P(D+) = \frac{P(T+) - P(T+/D-)}{P(T+/D+) - P(T+/D-)} = \frac{P(T+) - (1 - Specificity)}{Sensitivity - (1 - Specificity)}$$

$$P(D+) = \frac{(P(T+) + Specificity) - 1}{(Sensitivity + Specificity) - 1}$$

where P (D+) = prevalence of the disease

P (T+) = proportion of test positives

5. RESULTS

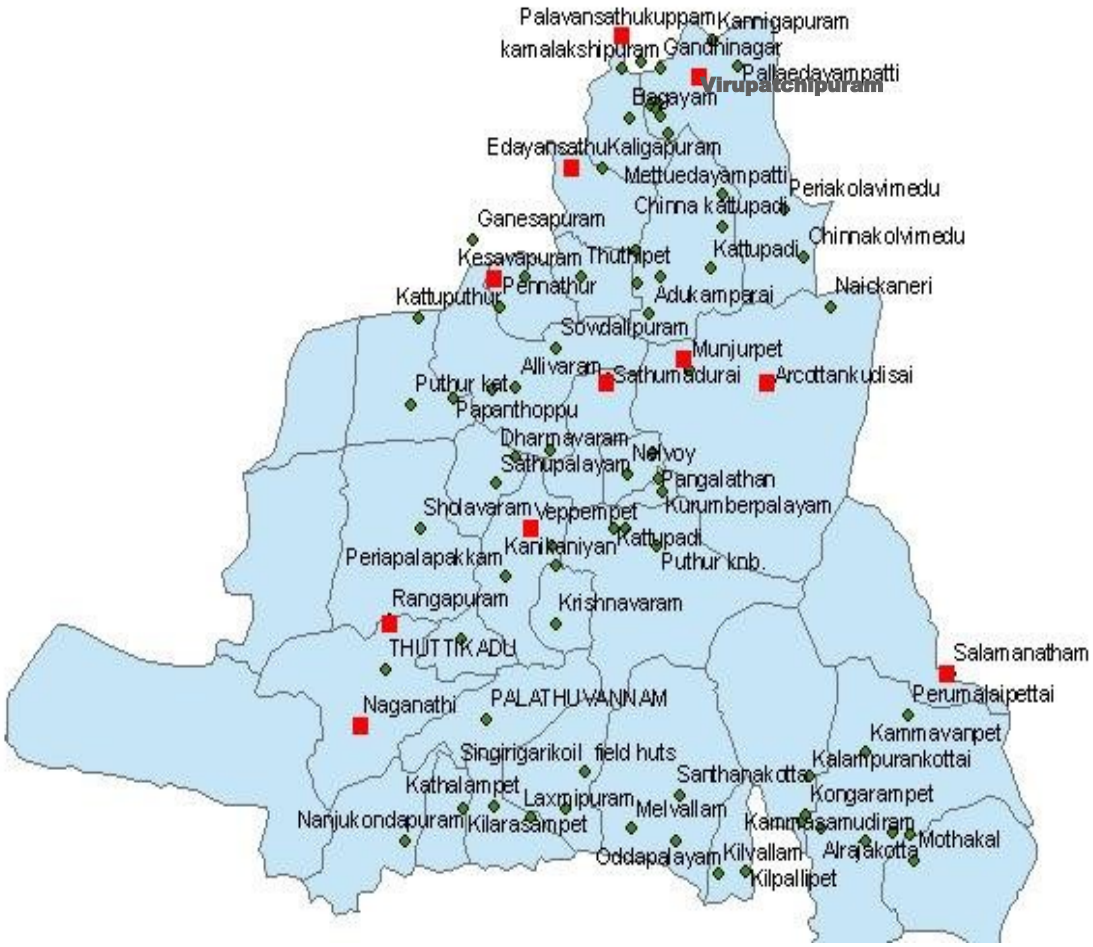
5.1 Baseline characteristics of the study population

Children who had completed second grade were enrolled into this study. A total of 259 children participated in this study. These were children aged 6-7yrs completed.

5.1.1 School wise distribution

Eleven schools across Kaniyambadi block, Vellore were included in this study.

Fig 6. Map of Kaniyambadi block showing the villages where the selected schools were located



Source: CHAD information database.[53]

Table 5. Distribution of the study population across the schools

School name	Number of children	Percentage of total study population
P.U Elementary School*, Arkottankudisai	17	6.6
P.U Elementary School, Edayansathu	25	9.7
P.U Elementary School, Kesavapuram	13	5
N.G.C.E Elementary School, Munjurpet	32	12.4
Aided Elementary School, Naganathi	17	6.6
P.U Elementary School, Palavansathakuppam	39	15.1
P.U Elementary School, Rangapuram	7	2.7
P.U Elementary School, Salmanatham	16	6.2
P.U Elementary School, Sathumadurai	15	5.8
P.U Middle School, Veppampet	11	4.2
P.U Elementary School, Virupatchipuram	67	25.9
Total	260	100

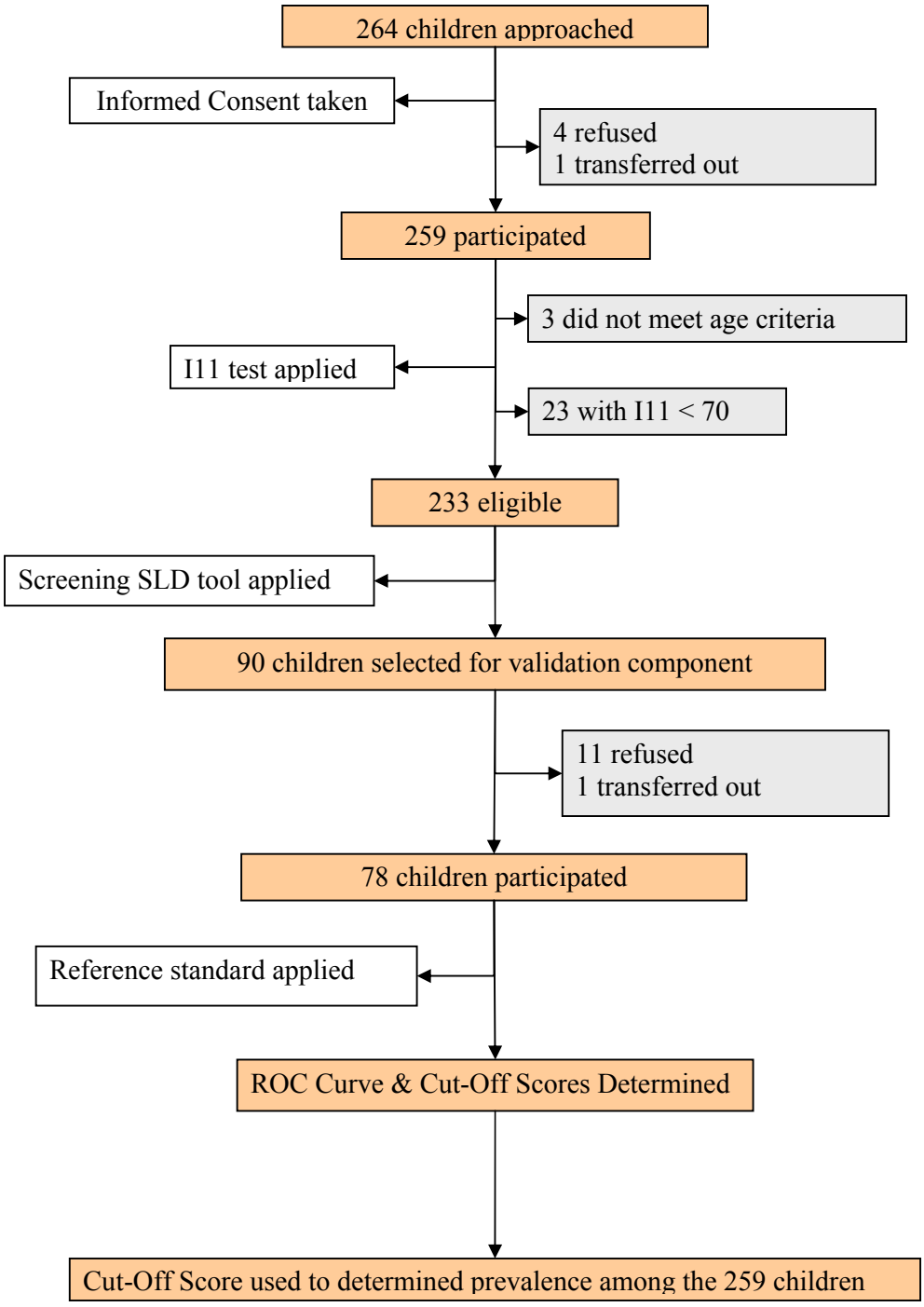
*P.U stands for Panchayat Union

5.1.2 Gender distribution of the children

Table 6. Distribution of the study population with respect to their gender

Gender	Number of children	Percentage of total study population
Girls	142	54.8
Boys	117	45.2
Total	259	100

Fig7. Outline of the Study Results



5.2 Results of the IQ test

A modified Binet-Kamat Test was used to check the IQ of the children.

Table 7. Results of the IQ test applied to the study population

IQ	Number of children	Percentage of total study population
≤ 70	23	8.8
> 70	236	91.2
Total	259	100

A total of 23 children were found to have an IQ < 70, and as per the study criteria, were ineligible for the rest of the study and were not subjected to the screening SLD tool.

An additional 3 children transferred out of their respective schools before the next tool could be applied.

5.3 Results of the screening SLD tool

The total number of children screened by the screening SLD tool was 233. The tool consisted of items with a maximum possible score of 83. Each correct answer was awarded 1 mark while an incorrect answer was awarded no mark or zero. The minimum total score achieved was 14 while the median score was 64. Of the 233 children, 175 (75%) were able to score better than 50% on this test.

Table 8. Description of scores achieved in the screening SLD tool

Category		Reading score	Writing score	Mathematics score	Total
Minimum score possible		0	0	0	0
Maximum score possible		24	20	39	83
Minimum score achieved		3	1	5	14
Maximum score achieved		23	20	40	83
Mean		15.76	13.52	27.91	57.18
Median		17	15	32	64
Mode		18	19	37	71
Standard deviation		4.57	5.25	9.95	18.54
Percentiles	25	13	9	20	43
	50	17	15	32	64
	75	19	18	36.5	72.5

5.4 Validation against the Reference standard

A total of 78 children were referred for diagnosis by a child psychiatrist. The distribution of these children based on their performance in the screening tool and by the child psychiatrist is described below.

5.4.1 Description of children seen by the child psychiatrist

Table 9. Distribution of the children based on their results in the screening SLD tool

Results in screening SLD tool	Number of children	Percentage
Low scorers	30	38.5
Mid range scorers	14	18.0
High scorers	34	43.5
Total	78	100

5.4.2 Description of results of diagnosis by the child psychiatrist

Table 10. Distribution of children based on the diagnosis of learning disability

Results	Number of children	Percentage
Children with learning disability	31	39.8
Children without learning disability	47	61.2
Total	78	100

Further description of the learning disabilities diagnosed (N=31):

- 18 children were found to have multiple disabilities along with learning disability and most of these were strongly suspected to have some form of mental retardation needing further evaluation.

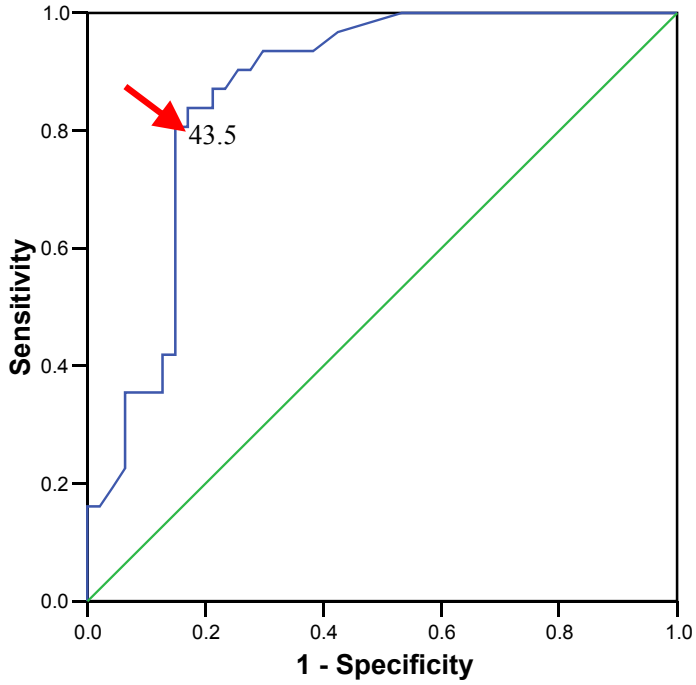
- 13 children were found to have true SLD
  - 8 of 13 (10.3% of 78) were found to have reading disability or dyslexia
  - 7 of 13 (9% of 78) were found to have writing disability or dysgraphia
  - 4 of 13 (5.1% of 78) were found to have disability in mathematics or dyscalculia

Table 11. Distribution based on type of learning disability identified

Type of disability	Number of children	Percentage
Reading only	3	23.0
Writing only	2	15.4
Math only	3	23.0
Both Reading & Writing	4	30.8
Mixed (presence of all 3)	1	7.8
Total	13	100

5.4.3 ROC curve

Fig 8. ROC curve based on results from the screening tool and the reference standard



The area under the curve was found to be 0.865 suggesting that the screening SLD tool is a good test to pick up learning disability.

5.4.4 Selection of the cut-off score for the screening SLD tool.

A child was considered as test positive if he scored less than the cut-off score while a child with a score of more than or equal to the cut-off score was considered as test negative.

- Test positive implies a high suspicion of presence of a learning disability
- Test negative implies a low or minimal suspicion of presence of a learning disability

Table 12. Sensitivity and specificity at the various cut-off points

Cut-off score	Sensitivity (%)	Specificity (%)
13	0	100
14.5	6.5	100
16.5	12.9	100
18	16.1	100
21	19.4	95.7
23	22.6	93.6
25.5	35.5	93.6
30.5	41.9	87.2
33.5	51.6	85.1
35.5	64.5	85.1
36.5	74.2	85.1
40	77.4	85.1
➔ **43.5**	**80.6**	**85.1**
46.5	83.9	83
50.5	83.9	78.7
56	87.1	78.7
62.5	87.1	76.6
65.5	90.3	74.5
71.5	93.5	70.2
74.5	96.8	57.4
75.5	100	46.8
76.5	100	36.2
78.5	100	21.3
79.5	100	8.5
82	100	4.3
84	100	0

5.4.5 Construction of the 2x2 table at the chosen cut-off score of 43.5

Disease positive here is defined as any child with learning disability (in the presence or absence of other disabilities).

Table 13. Comparison of the results of the screening SLD test and the reference standard

		Learning disability		Total
		Positive	**Negative**	
Screening SLD Tool	**Positive**	25 a	7 b	32
	Negative	c 6	d 40	46
Total		31	47	78

5.4.6 Sensitivity & Specificity

Sensitivity = $\frac{a}{(a+c)} = \frac{25}{(25+6)} = \frac{25}{31} =$ 0.806 or 80.6%

Specificity = $\frac{d}{(b+d)} = \frac{40}{(40+7)} = \frac{40}{47} =$ 0.851 or 85.1%

5.4.7 Predictive values

Positive predictive value = $\frac{a}{(a+b)} = \frac{25}{(25+7)} = \frac{25}{32} =$ 0.781 or 78.1%

Negative predictive value = $\frac{d}{(c+d)} = \frac{40}{(40+6)} = \frac{40}{46} =$ 0.869 or 86.9%

5.4.8 Likelihood ratio (LR)

LR = $\frac{Sensitivity}{(1-Specificity)} = \frac{0.806}{(1-0.851)} =$ 5.41

5.5 Reliability of the screening SLD tool

5.5.1 Test-retest reliability

Of the 78 children who underwent diagnosis by the child psychiatrist, 13 (16.7%) were retested by the same investigator. The correlation between the scores of both tests was high.

Fig 9. Comparison of scores in the initial test and the retest

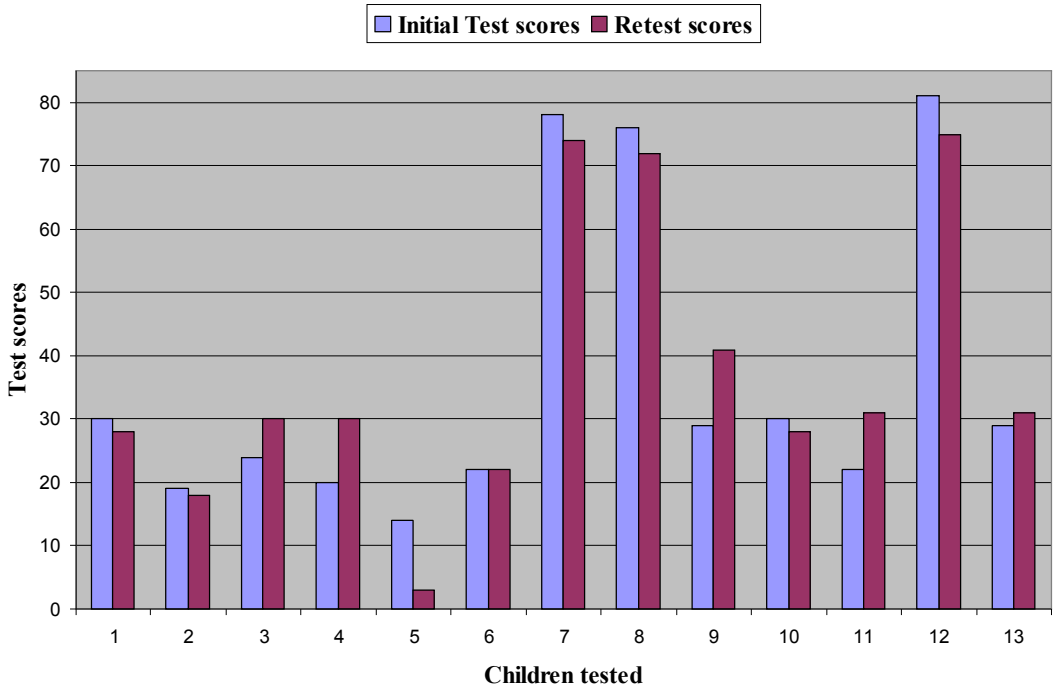


Table 14. Agreement between results from test and retest

		Initial Test		Total
		Test Positive	Test Negative	
Retest	Test Positive	10	0	10
	Test Negative	0	3	3
Total		10	3	13

Kappa = 1.0

Intra class correlation coefficient = 0.958 (0.869-0.987)

5.5.2 Inter-rater reliability

Of the 78 children who underwent diagnosis by the child psychiatrist, 7 (9.0%) were retested by an external investigator. The correlation between scores given by both investigators was high.

Fig 10. Comparison of scores by both investigators

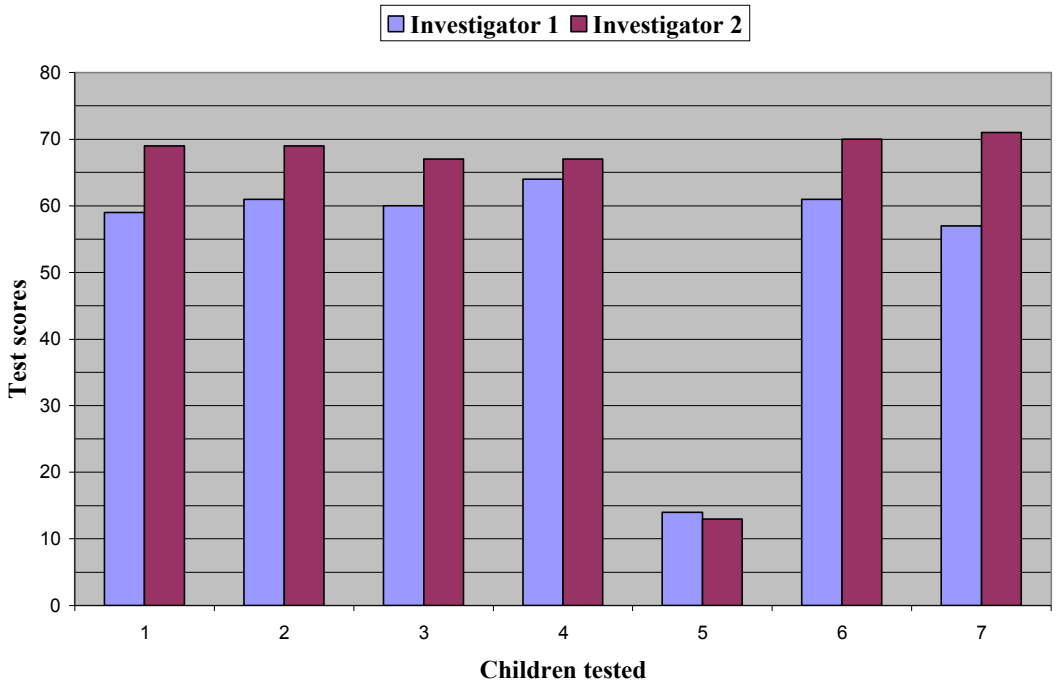


Table 15. Agreement between results by both investigators

		Investigator 1		Total
		Test Positive	Test Negative	
Investigator 2	Test Positive	1	0	1
	Test Negative	0	6	6
Total		1	6	7

Kappa = 1.0

Intra class correlation coefficient = 0.969 (0.830-0.995)

5.6 Prevalence of Learning Disability in the study population

The cut-off score of 43.5 was applied to scores of the 259 children who had participated in the study. This divided the group into 2 categories – test positive and test negative. Based on the respective proportions, the prevalence of learning disability in second graders was estimated,

5.6.1 Number of Test positives in the study population (score < 43.5) = 81

5.6.2 Proportion of Test positives in the study population = $\frac{81}{259}$ = 0.312 or 31.2%

5.6.3 Gender distribution

Table 15. Distribution of the study population with respect to gender

Gender	Test Positive	Test Negative	Total
Girls	38 (26.8%)	104 (73.2%)	142 (100%)
Boys	43 (36.8%)	74 (63.2%)	117 (100%)
Total	81	178	259

5.6.4 True prevalence of learning disabilities in study population

$$\text{Prevalence} = \frac{(p + Specificity) - 1}{(Sensitivity + Specificity) - 1} = \frac{(0.312 + 0.851) - 1}{(0.806 + 0.851) - 1} = \frac{0.165}{0.657} = 0.248 \text{ or } 24.8\%$$

Where p = proportion of test positives in the screened population

Hence, the prevalence of learning disability in the study population is calculated to be 24.8% (95% CI 19.8 – 24.8).

6. DISCUSSION

6.1 Background

This study was considered as the first step in research on learning disability in vernacular schools in Tamil Nadu. Diagnosis by a team of doctors is essential but considering the number of children to be screened, this process is not only time consuming but also practically and economically not feasible. The challenge was to determine if detection of learning disability could be done at the school level itself with a simple screening instrument in hand.

This study was undertaken to develop and validate a simple screening tool for learning disability in school going children in second grade. This study was carried out in Government and Aided Elementary and Middle schools in Kaniyambadi block in Vellore district.

Literature review in the subject revealed that most studies had been done in western countries alone. The few done in India had used an English based tool and hence, the studies had been conducted in urban English medium schools.[9,10,44] Some studies used a locally developed tool in the native language to detect children with learning disability who were further evaluated to identify risk factors or to identify beneficial interventions. However there was no mention regarding their comparison against internationally accepted reference standards, thus their validity can be questioned.[11,12,43]

During the course of this study, a screening tool was developed in the Tamil language based on the curriculum of the Educational Board in this State. This was then validated against the reference standard which in this study was the DSM IV-TR criteria. The methodology and results at each stage has been discussed below.

6.2 Development of the screening tool

The first objective of this study was to develop a screening tool to detect Specific Learning Disability (SLD) in children studying in the second grade.

An ideal tool would have been based on the normative skills developed by children of that specific age and anyone who fell below 2 standard deviations would be considered as test positive. Unfortunately the normative data for children with respect to the Tamil language was not available. Collecting such data was beyond the scope of this study and hence, an alternative approach was looked for. As mentioned earlier, many studies done across India had widely recommended the curriculum based assessment and so this was the basis of development of the screening tool in this study.[11,12,37,38] This also seemed like the right approach as it would embed a familiarity and simplicity that would allow any special educator or teacher who used this tool to understand it better.

Also in most states like Tamil Nadu, the native language is the primary language of thought and communication. Hence, tools developed in English could not be utilized here.

The process of preparing the screening tool was based on experience of the experts in child psychiatry. Literature available in this area proved to be lacking. There were many instructions for setting an academic test paper but none regarding the actual development of the test.

The actual development of this test began much prior to setting the questions. It involved:

- Orientation into the subject of learning disability
- Understanding the goals or teaching objectives of the syllabus at that specific level

- Discussions with experienced faculty on the subject, problems faced by the children and their expectations
- Discussions with child psychiatrist with respect to the child's normal developmental abilities at that stage and common learning disabilities faced by them
- Detailed workup of the curriculum set by the State's Education Board
- Creating the tool based on the curriculum.
- Review of the tool by Tamil speakers for further refinement of language used
- A pilot application of the tool in few children to identify practical limitations, too simple or too difficult questions

This process was time-consuming for both the researchers and the resource people contacted. One striking observation during this stage was the deep understanding of a child's abilities and difficulties in his teachers. The cooperation and contribution of the Government School teachers to the development of this tool in the absence of any incentive was remarkable and needs to be mentioned.

6.3 Application of the screening tool

The primary question here was who would apply the screening tool in the study. The obvious choice was a school teacher as the tool was developed to be used by teachers. The tool was based on the curriculum which allows an element of familiarity to the teacher. It was designed with simple scoring techniques with a right or wrong approach. With minimal instructions, it is easy to understand and use. The difficulty arose when one realized the magnitude of work the teachers currently have with implementation of the new Activity Based Learning method recently introduced in schools across Tamil Nadu. Also knowledge of the child's scholastic performance could bias testing children

the teacher knew already. The SSA programme has called for special teacher educators who will be trained to help disabled children.[4] This teacher's main focus will be detection and remedial education for disabled and slow learners. This teacher will easily be able to apply the tool. The fact that it was created to detect learning disability at the entry level will keep the numbers low and will cause maximum benefit with appropriate intervention.

Since the study required the full time involvement of a teacher or an equivalent person for 3-4 months, a social worker, with prior experience as an interviewer in studies conducted by the Department of Community Health, was chosen to help develop and apply the Screening SLD tool. Unlike the teacher, the social worker had no idea regarding the scholastic performance of the children and hence could exercise no bias towards testing the children. As the social worker was the only investigator who applied the test, it is safe to assume that the method of testing all the children was the same and unbiased.

Applying the tool at the school level proved to be advantageous in that it minimized anxiety among parents particularly when compared with the option of sending the children to a tertiary centre. Another benefit was that it simulated the scenario in which children would subsequently be screened if the tool was found to be effective.

6.4 Diagnosis with the reference standard

The second objective of this study was to validate the screening tool using the DSM IV-TR criteria as the reference standard.

The 78 children selected were subjected to diagnosis by child psychiatrists. The psychiatrist was unaware of the child's performance in the screening SLD tool and this helped avoid any bias that could creep in at this stage. The assessment of the psychiatrist

was therefore completely independent. A total of 31 children were found to have learning disabilities. Of these 31, 18 children were found to have multiple disabilities and most were suspected of having some degree of mental retardation. It was inevitable that such children would perform poorly in any test created to test their learning disabilities. The initial IQ test screening enabled the exclusion of those with severe mental retardation; however those with milder forms did enter the study. Since the future application of this tool by school teachers will not be preceded by an IQ testing, test positives will include not only include children with SLD, but also children with mild and severe mental retardation. While this will reduce the specificity of the tool with specific reference to SLD, the identification of children with mental retardation will be beneficial since these children would require further evaluation and more complex intervention.

The remaining 13 children (16.6% of 78) were detected to have true SLD. Of these, single disability of either type was found in 8 children, while 4 had dual disability – the commonest type seen being reading with writing. One child was found to have a mixed type which meant that all 3 types of SLD were present. Reading (10.3% of 78) and writing SLD (9% of 78) dominated those of mathematic (5.1% of 78). The co-occurrence of learning disabilities should be expected given the developmental relationships between listening, speaking, reading, spelling, writing, and mathematics.[7]

6.5 Test accuracy

Accuracy of the screening SLD tool to detect children with learning disability was done using the DSM IV-TR criteria as the reference standard. The sensitivity and specificity for the screening tool are high but the Likelihood Ratio (LR) is a more appropriate reflection of the capabilities of the tool. The LR is independent of prevalence estimates. A likelihood ratio of 5.4 for a positive test was found in this study and it implies that of

10 children who get a low score, 5 to 6 will truly have a learning disability. This LR though positive can be improved on. Further refinement of the tool via factor analysis can be considered as the next step. This will help condense the tool enabling selection of specific and discrete items and exclusion of the weaker ones.

6.6 Prevalence of learning disability

The final objective of this study was to estimate the prevalence of SLD in children studying in second grade across a rural block This figure did not represent the proportion of children with learning disability in the area but essentially was the proportion of children that the school or Government could focus its interventions on to receive maximum benefit with limited resources.

In this study, 31.2% (81) children fell below the cut-off score. This was the proportion of test positives. The true prevalence was calculated to be 24.8% i.e. around 64 children of the 259 would truly have learning disability in the presence or absence of other cognitive or affective disorders or mental retardation. It is important to remember that this figure is seemingly high as it is an age-specific prevalence estimation and that the overall prevalence across all age groups could be lower or higher. This is due to the fact that it would be difficult to pick up such learning disability at an earlier age as it would have a more subtle presentation. Hence a trend could be expected where the prevalence would increase with age due to increasing severity of the disability and hence the increased ease in detection. However the later it is detected, the less effective is the remedial intervention to help correct such learning disability.[7]

7. LIMITATIONS

1. Absence of normative data for children with respect to the Tamil language.
2. Lack of guidelines for development of a psychometric tool.
3. The IQ test could have been conducted by a trained special educator or psychologist. This way the exact IQ could have been measured. The main reasons this was not done were that this would not have affected the results in anyway, it would have been time-consuming and funds for extra personnel were not available. However it would have been ideal way to test for IQ.
4. In a study to test the diagnostic accuracy of a test or tool, the study has more power and the results more accurate if all the children screened by the screening test are subjected to the reference standard. This was however was not feasible for the purpose of this study due to the constraints of time and manpower.
5. Another hurdle was the intimidation that tertiary hospitals have in most rural homes. While almost all parents consented to evaluation of children in their respective schools, when the question of being taken to a tertiary centre especially a psychiatric facility for further evaluation came up, many parents backed out. The main reason given for this was that they did not consider their child to be “mentally unstable”. They realized that their child may have been performing poorly in school however they attributed this to “normal” difficulties any child could face in learning.
6. Many children transferred out of their schools in the midst of the academic year. Parents were unavailable for any comment on this issue.

8. SUMMARY & CONCLUSIONS

Through this study we have attempted to create a simple yet specific screening tool in the native language Tamil to detect learning disability in school going children. This tool is based on the curriculum as laid out by the Education Board. It is simple to understand and implement and the user does not need to be highly qualified. The process of development of the tool suggests that similar tools can be developed in other languages as well.

One area of research that needs a lot of work still, as mentioned earlier, was development of a psychometric tool. Non-availability of a set of guidelines to direct the team led us to formulate simple steps based on prior experience and expertise offered by the child psychiatrists.

The screening tool was created to screen children at an early stage in Elementary schools. This is vital as the longer children with disability in basic learning skills go without identification and intervention, the more difficult becomes the task of remediation and hence, the rate of success becomes lower.

As seen from the results discussed earlier, this tool will not only detect children with specific learning disability who ordinarily would go unnoticed, but also identify children with mental retardation and other disabilities due to their poor performance. This is important as it allows children with learning disabilities to be referred for further evaluation and management. This is similar to a “High-Risk” approach in screening programmes. The benefits of this would be tremendous especially when compared to the existing scenario where such children are labeled as poor performers and eventually drop out of school after being subject to considerable stress both at school and at home.

The screening tool when validated against the DSM IV-TR criteria had a high sensitivity of 80.6% and a higher specificity of 85.1% with a positive likelihood ratio of 5.4. In this study, of the 259 children screened, 81 children were found to be test positive and based on our calculations, 64 children i.e. 24.8% would truly require some intervention. The validity of this tool suggests that it could be introduced into the elementary education system, initially on a small scale, following which its scope can be widened.

Another striking observation was the type of disabilities identified.. In this study, of the 78 children who were subjected to detailed diagnosis, 10.3% had reading disability and 9% had writing disability in Tamil while only 5.1% had a problem in mathematics. Hence, despite Tamil being the primary language of thought and communication in these schools and families, a significant proportion had a disability involving this language. This only emphasizes the need for further research into language disabilities which varies from state to state in a diverse country like India.

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APPENDIX

Appendix I.

Screening Tool for Specific Learning Disability

Section A. வாசித்தல்

1. எழுத்துக்களை உச்சரித்தல்: (5)

   1.ல 2. ழ 3. ஞ 4. ங 5.ட

2. வார்த்தைகளை உச்சரித்து அதன் படத்தைக் குறிப்பிடவும்: (5)

   Card.A2

   1. பள்ளி, பல்லி
   2. வாள், வால்
   3. தழை, தலை
   4. மலை, மழை
   5. தவலை, தவளை

3. படங்களில் உள்ள செயல்களை குறிப்பிட்டு சொற்களை இணைத்துத் தொடர் உருவாக்கு: (5) **Card.A3**

   இவன் என்ன செய்கின்றான்?

   1. சாப்பிடுதல்
   2. வாசித்தல்
   3. தூங்குதல்
   4. குடித்தல்
   5. உட்கார்ந்திருத்தல்

4. ஆண் / பெண் வேறுபாடுகளை படத்தைப் பார்த்துக் குறிப்பிடவும்:(3) **Card.A4**

    1. அவள் எழுதிக்கிறாள்
    2. அவன் படிக்கிறான்
    3. அவள் அழுதுகொண்டிருக்கின்றாள்

5. எதிர்ச் சொற்களைக் குறிப்பிடவும்: (3)

    1. பெரிய X சிறிய
    2. ஆண் X பெண்
    3. இடது X வலது

6. கொடுக்கப்பட்டுள்ள வார்த்தைகளைக் கொண்டு தொடர் உருவாக்கு:(3) **Card.A6**

    1. பையன் ரவி நல்ல.
    2. பள்ளிக்கு உமா சென்றாள்.
    3. பட்டம் சங்கர் விட்டான்.

Ans:

    1. ரவி நல்ல பையன்.
    2. உமா பள்ளிக்கு சென்றாள்.
    3. சங்கர் பட்டம் விட்டான்.

Section B. எழுதுதல்

1. இங்கு குறிப்பிட்டுள்ள எழுத்துக்களை எழுதிக் காட்டவும்: (5)

   Card.B1

   1.ப 2.ல 3. க 4. ஜ 5. ஜ

2. இங்கு குறிப்பிட்டுள்ள எழுத்துக்களை எழுதிக் காட்டவும்: (5)

   1. க 2. ம 3. ச 4. ஸ 5. ழ

3. விடுபட்ட எழுத்துக்களை நிரப்புக: (5) **Paper.B3**

   1) பட்டம் → (ட், ம்)

   2) கப்பல் → (ம் , ப், ல், ள்)

   3) தாத்தா → (த , த், தி)

   4) யானை → (னை, லை)

   5) கிளி → (லி , பி, ளி)

4. எழுத்துக்களை சரியாக வரிசைப்படுத்தி வார்த்தைகளை எழுதவும்: (5) **Paper.B4**

   1. ழபம் – பழம்

   2. துபந் – பந்து

   3. ம்அமா – அம்மா

   4. ககாம் – காகம்

   5. ல்கட – கடல்

Section.C கணக்கு

1. கீழ் கொடுக்கப்பட்டுள்ள எண்களை கண்டறியவும் (கூறவும்):

   (5) **Card.C1**

   3 9 17 69 57

2. கீழ் கொடுக்கப்பட்டுள்ள எண்களை எழுதிக்காட்டவும்: (5)

   6 8 33 27 67

3. கீழ் கொடுக்கப்பட்டுள்ள எண்களை பார்த்து எழுதவும்: (5)

   Card.C3

   96 71 38 56 89

4. i. கூட்டல் : (5) **Paper.C4i**

   4 + 3 =

   5 + 5 =

   6 + 3 =

   20 + 30 =

   15 + 15 =

   ii. கழித்தல் : (5) **Paper.C4ii**

   8 - 4 =

   7 - 2 =

   9 - 6 =

   10 - 3 =

   15 - 5 =

5. **எண்ணி** விடை கூறு: (3) **Card.C5**

9 14 30

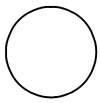
6. **எண்ணி** அட்டைகளை சரியாக அடுக்குதல்: (2)
(முன்னோக்கி, பின்னோக்கி 52 முதல் 59 வரை)

7. **பத்துப் பத்தாக** எண்களை பிரித்துக் காட்டவும்: (3) **(Pencils)**

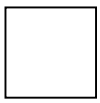
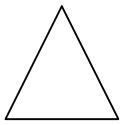
30 25 13

8. எண் **20** தொடங்கி பின்நோக்கி கூறவும்: (2) (eg: 20, 19, 18….)

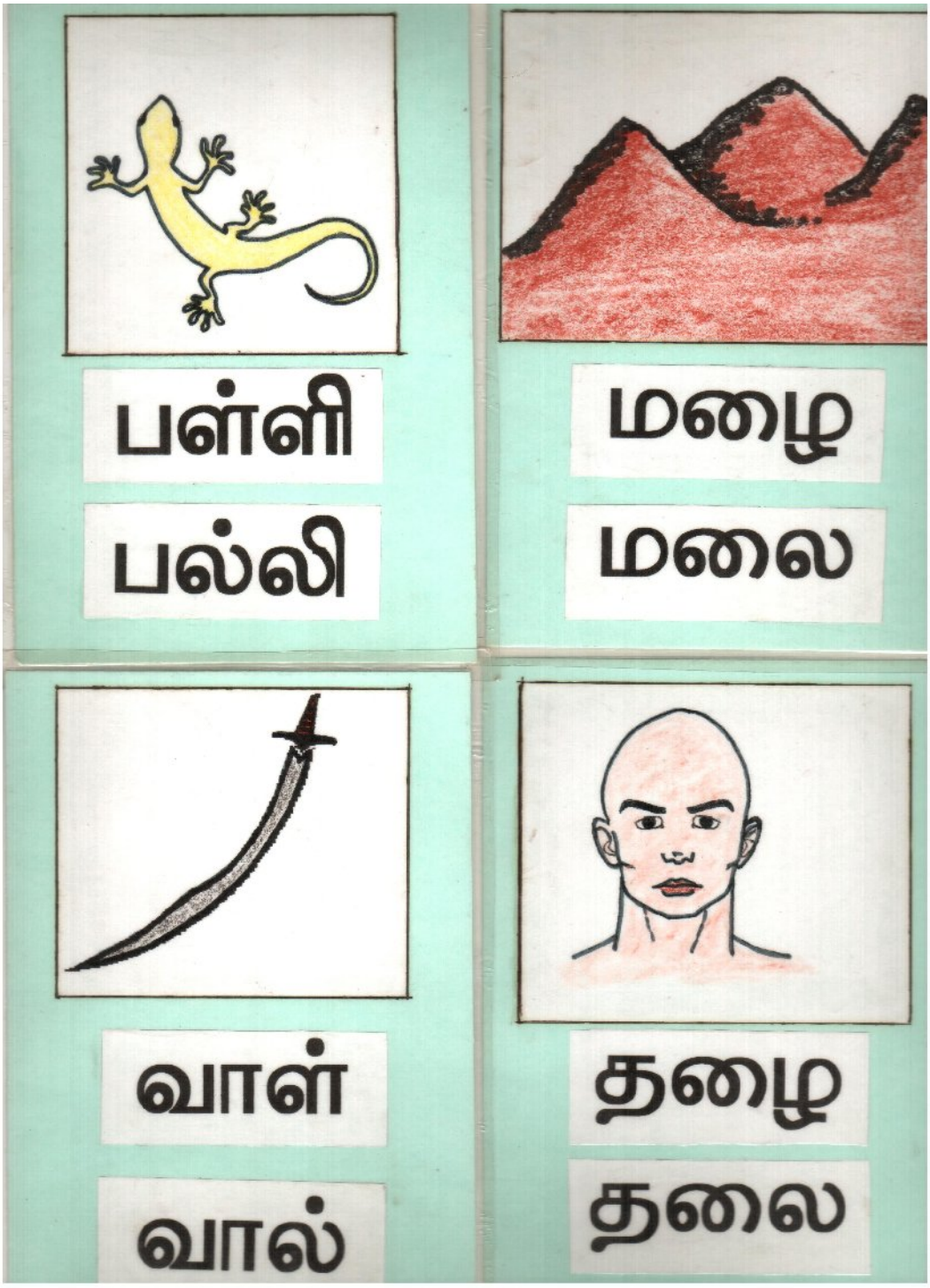
9. வடிவங்களைக் கண்டு கூறவும்: (2) **Card.C9**

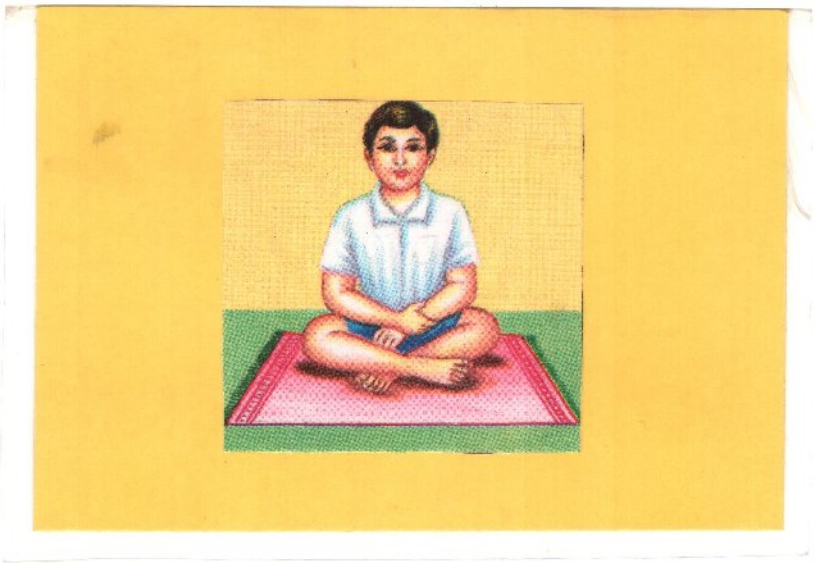
1.  2. 

பின்னர் வரைந்தல்: (2)

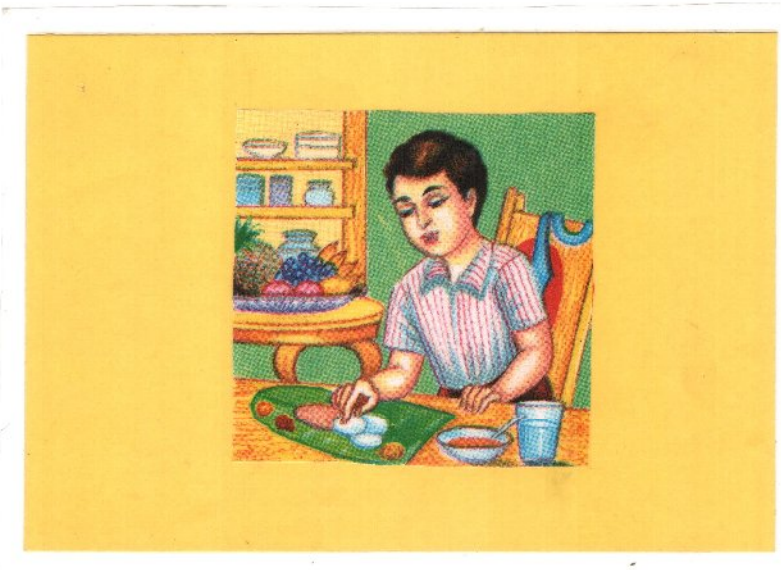
3.  4. 

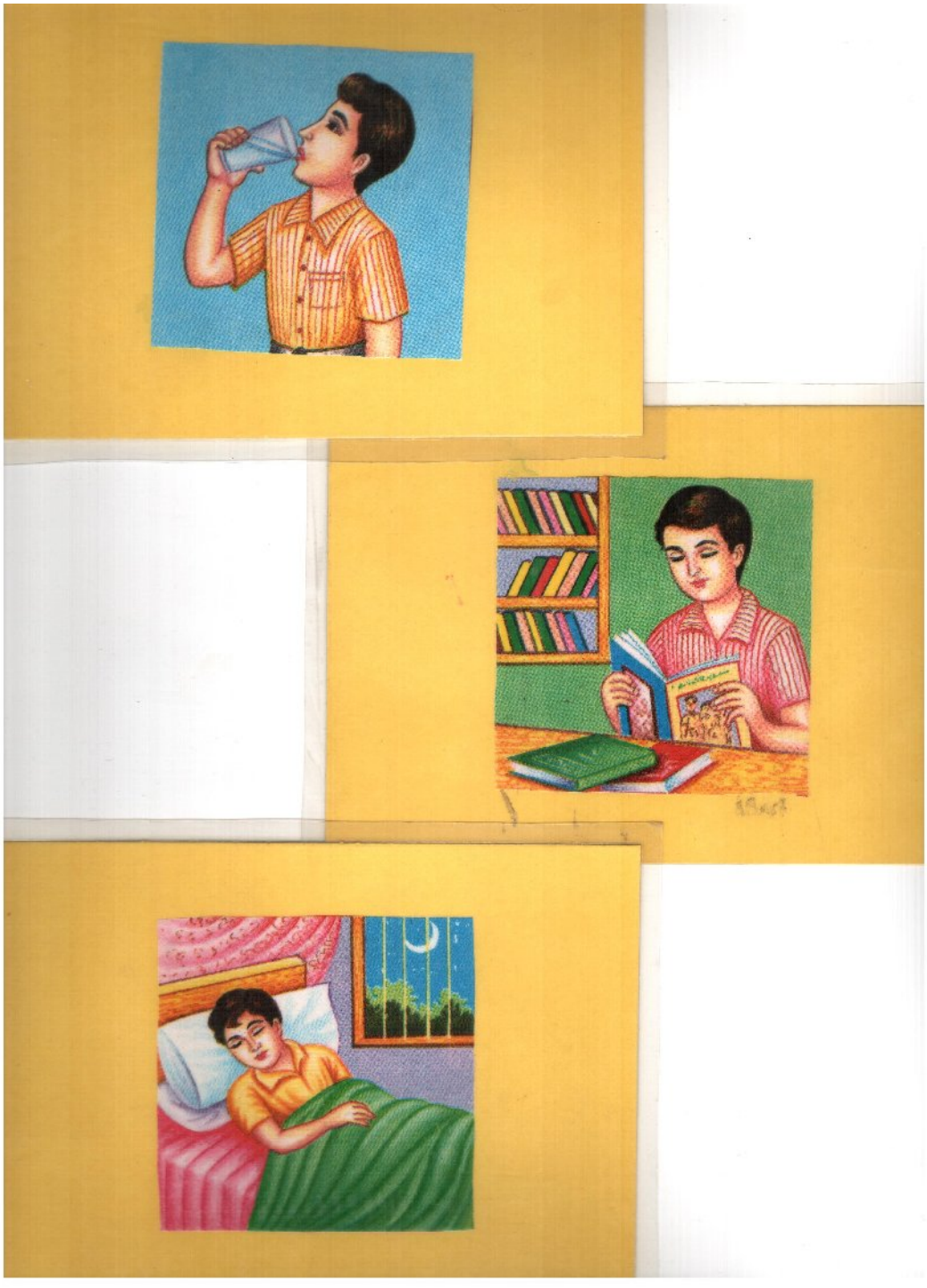
CARDS A2


பள்ளி
பல்லி
மழை
மலை
வாள்
வால்
தழை
தலை



CARDS A3





CARDS A4

ரவி பையன் நல்ல

பள்ளிக்கு

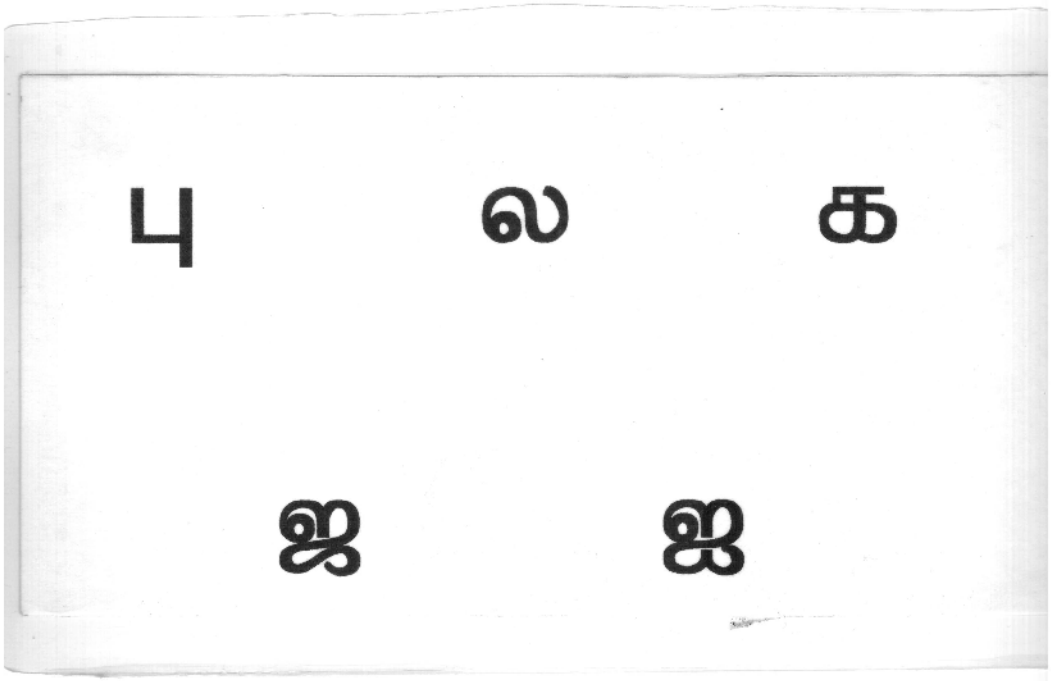
உமா சென்றாள்

விட்டான்

சங்கர் பட்டம்

CARDS A6

CARD B1



Paper.B3

1. ப __ ட __ → (க் , ட், ம்)

2. க __ ப __ → (ம் , ப், ல், ள்)

3. தா __ தா → (த , த், தி)

4. யா __ → (னை, லை)

5. கி __ → (லி , பி, ளி)

Paper.B4

1. ழ ப ம் —

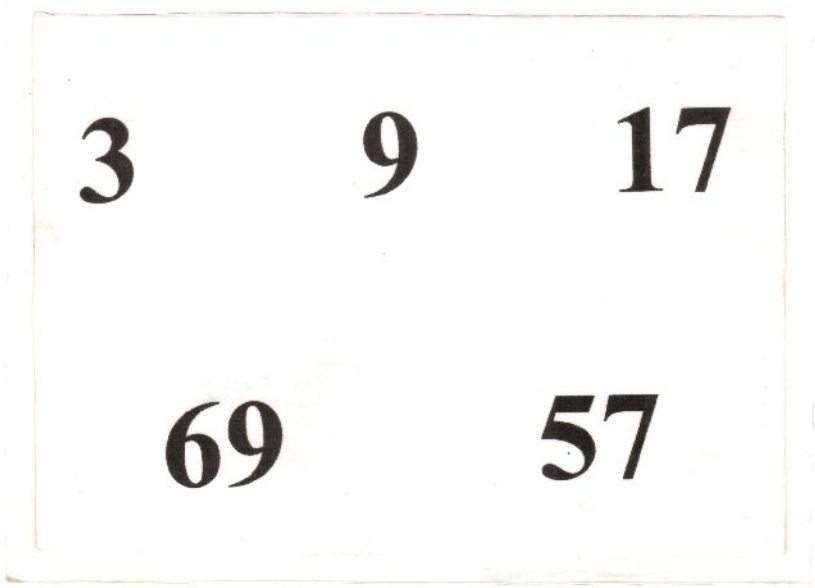
2. து ப ந் —

3. ம் அ மா —

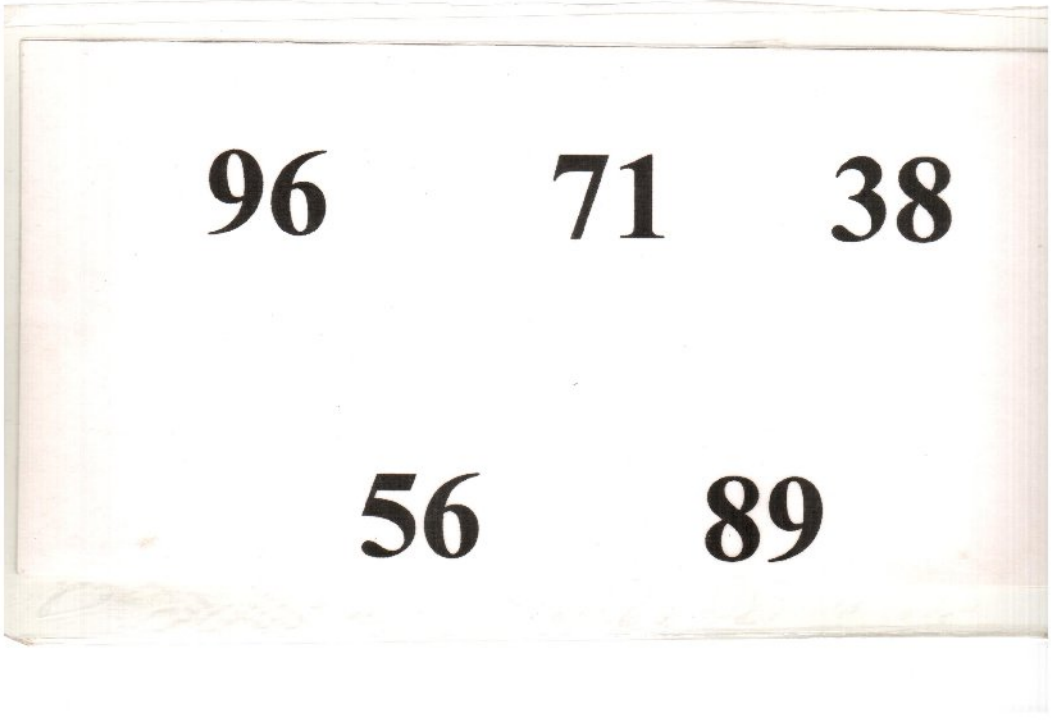
4. க க ா ம் —

5. ல்கட —

CARD C1



CARD C3



Paper.C4i

$$\begin{array}{r} 4 \\ +\ 3 \\ \hline \square \end{array}$$

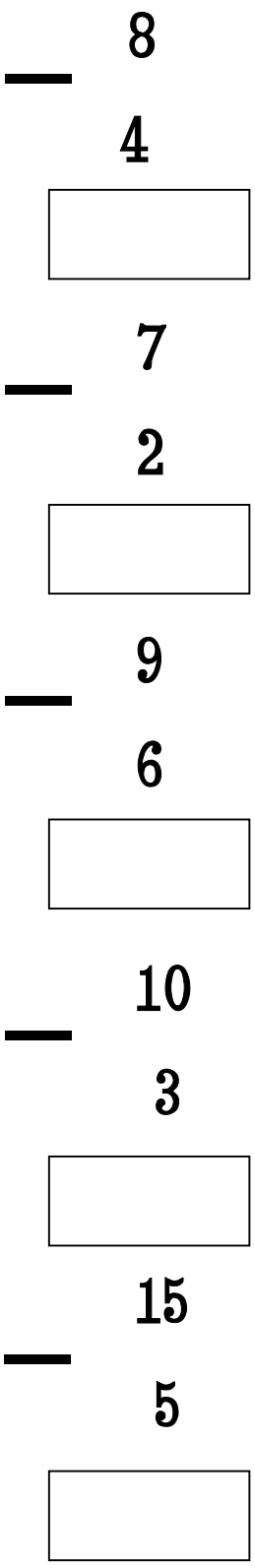
$$\begin{array}{r} 5 \\ +\ 5 \\ \hline \square \end{array}$$

$$\begin{array}{r} 6 \\ +\ 3 \\ \hline \square \end{array}$$

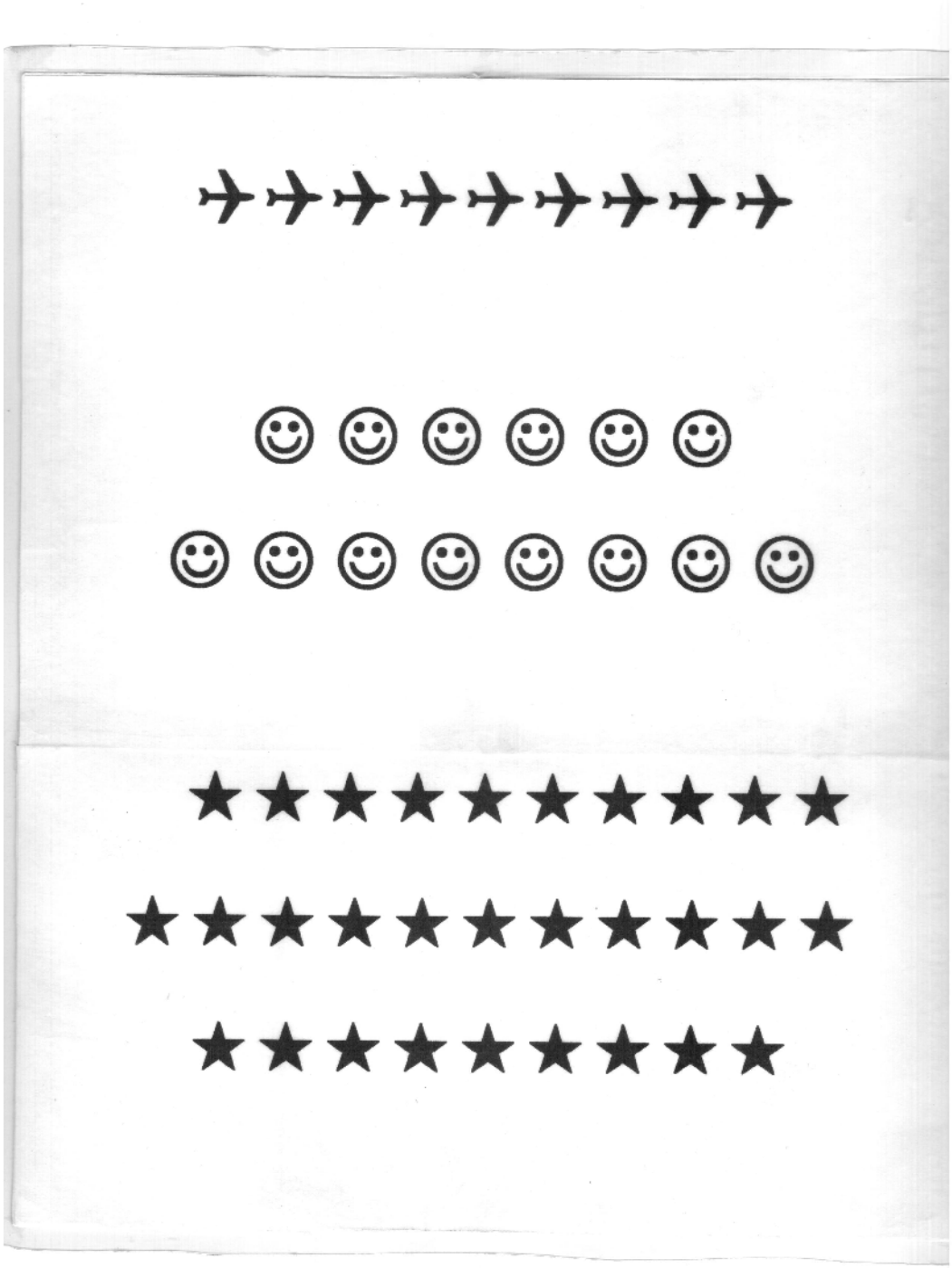
$$\begin{array}{r} 20 \\ +\ 30 \\ \hline \square \end{array}$$

$$\begin{array}{r} 15 \\ +\ 5 \\ \hline \square \end{array}$$

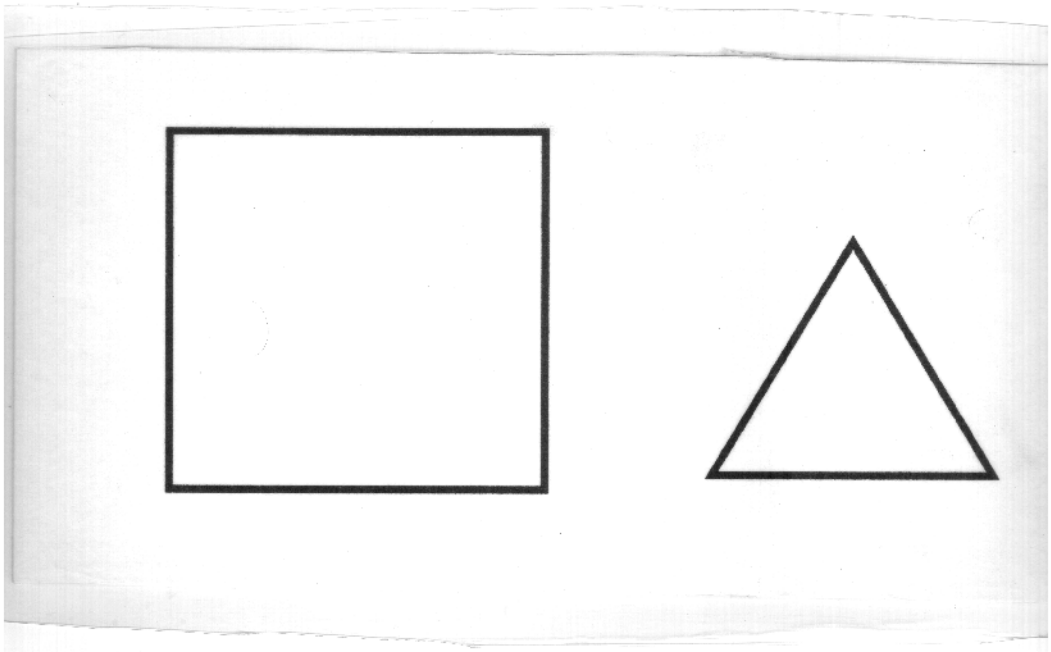
Paper.C4ii

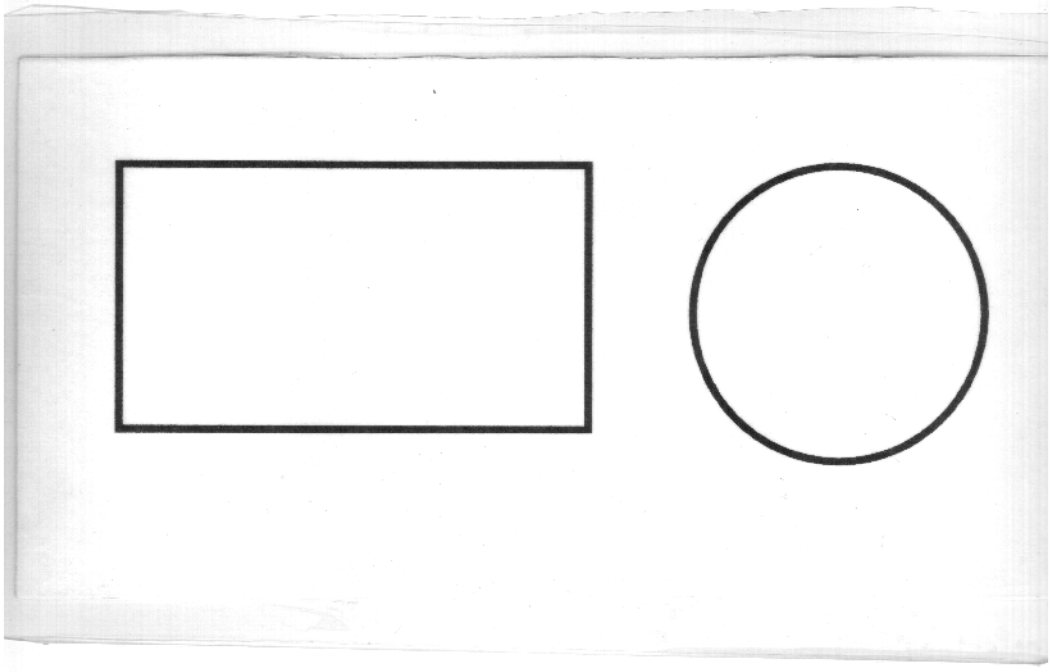


CARD C5



CARDS C9





Appendix II.

Scoring Card - Screening Tool for Specific Learning Disability

ID No.

Name:

Age:

Sex:

Father's Name:

Class: **Section:**

School Name:

Address (Detailed):

House No –

Street –

Village –

Town/City –

ID No.

Total Score = Section A + Section B + Section C

= ☐ + ☐ + ☐

= ☐

Highest score = 24 + 20 + 39

= 83

Section A. வாசித்தல்

Serial No.	Score	Maximum Score
1.		5
2.		5
3.		5
4.		3
5.		3
6.		3
Total		24

Section B. எழுதுதல்

Serial No.	Score	Maximum Score
1.		5
2.		5
3.		5
4.		5
Total		20

Section.C கணக்கு

Serial No.		Score	Maximum Score
1.			5
2.			5
3.			5
4.	i		5
	ii		5
5.			3
6.			2
7.			3
8.			2
9.	i		2
	ii		2
Total			

Appendix.III

INFORMED CONSENT FORM TO PARTICIPATE IN RESEARCH

Development and Validation of a Screening Tool for Specific Learning Disability in School Going Children in Rural Tamil Nadu

PURPOSE OF STUDY

Your child has been invited to participate in this research study on learning disability in school going children. Learning disability refers to a group of disorders in listening, speaking, reading, writing, and mathematics. These skills are essential for success at school and at workplace, and for coping with life in general

The purpose of this research study is to develop a tool to help screening for learning disability in school going children. Once this tool is developed and shown to work from this study we will be able to detect this problem in children and will be able to help them better.

Please read all of the information or listen to the person explaining it to you carefully. Ask to have explained to you, any words, terms, or sections that are unclear. Your child's participation in this study is entirely voluntary. You will be asked to sign this agreement which states that the study has been explained, and that your questions have been answered.

This study is being conducted by Christian Medical College, Vellore.

PROCEDURES TO BE FOLLOWED

The total length of this study is eight months. There will be 240 children enrolled in this study. The child's participation is needed for four months only.

In order to take part in this study, your child will be tested for his/her IQ which will qualify him/her for the study. Once qualified, he/she will be subject to the new screening tool in his school only. He/She will also be assessed by a doctor or psychologist using the standard assessment to diagnose the presence of learning disability.

All this will be done free of charge. Doctors and social workers will talk to you to explain the results of these tests. If your child is found to have a low IQ or is diagnosed to have learning disability, they will also explain what needs to be done and what your choices are for follow up and treatment.

Participation in this study will have no impact on your child's schoolwork. Your child is free to stop participating in this study at any time for any reason. Your decision to not participate or to discontinue participation will not involve any penalty or loss of benefits to which your child is otherwise entitled.

RISKS

There is no foreseeable harm or discomfort to your child because of participation in this study.

BENEFITS

You will be informed about the results of all tests carried out on your child. If your child is found to have a low IQ or is diagnosed to have a learning disability, he will be referred to Department of Child and Adolescent Psychiatry for a consultation and assessment. This will be free of charge. However expenses for any subsequent treatment that your child may require will have to be borne by you.

CONFIDENTIALITY

Data obtained from your child will be recorded using a unique study identification number. Your child's name and record number will not appear on any of the study paperwork. A log that links your child's name to your child's study identification number will be kept in a locked file which can be accessed only by investigators on this study. Any publication arising from this study will maintain your child's anonymity by excluding all information that could possibly identify your child. Your child's records pertaining to this study may be reviewed by representatives of the Indian Council for Medical Research (ICMR) or the Christian Medical College Institutional Ethics Committee.

IMPORTANT PHONE NUMBERS

If you have questions about this study at any time, please call:
Dr.Tanya Seshadri - 9442379303
Mrs. Gifta Priya Manohari - 9894093065

COSTS

This study is supported by Christian Medical College, Vellore.

PAYMENT

You or your child will not receive any payment for participating in this study. Since the study personnel will visit your child's school or your home, we do not anticipate that you will incur any additional expenditure by participation in this study. Cost for travel to Department of Child and Adolescent Psychiatry will be met for through this study.

PARTICIPANT'S STATEMENT

I have read this consent form and have discussed with Dr. Tanya Seshadri or her representative the procedures described above. I have been given the opportunity to ask questions, which have been answered to my satisfaction. I understand that any questions that I might have will be answered verbally or, if I prefer, with a written statement.

I understand that I will be informed of my child's status with respect to presence of learning disability at the end of this study.

I understand that my participation is voluntary. I understand that I/my child may refuse to participate in this study. I also understand that if, for any reason, I/my child wishes to discontinue participation in this study at any time, I/my child will be free to do so, and this will have no effect on his/her future care.

I have been fully informed of the above-described study with its risks and benefits, and I hereby consent to the procedures set forth above. I have received a signed copy of this consent form.

I understand that as a participant in this study my child's identity and records and data relating to this research study will be kept confidential, except as required by law, and except by ethics committee members, regulatory agencies, and the study sponsor if required.

_____ _____

Parent/Legal Guardian (Signature or Thumb print) Date

Appendix.IV

ஆராய்ச்சியில் பங்கெடுப்பதற்கான ஒப்புதல் படிவம்

Development and Validation of a Screening Tool for Specific Learning Disability in School Going Children in Rural Tamil Nadu

ஆராய்ச்சியின் நோக்கம்:

பள்ளிக்குச் செல்லும் குழந்தைகளிடையே ஏற்படும் கற்றல் குறைபாடுகள் பற்றிய ஆராய்ச்சியில் பங்குகொள்ள தங்கள் மகன் / மகள் அழைக்கப்படுகிறார். கற்றல் குறைபாடு என்பது கேட்டல், பேசுதல், படித்தல், எழுதுதல் மற்றும் கணிதம் ஆகியவற்றில் ஏற்படும் குறையைக் குறிக்கும். இந்தத் திறமைகள் பள்ளியிலும் எதிர்காலத்தில் வாழ்க்கையிலும் வேலை செய்யும் இடத்திலும் வெற்றி பெறுவதற்கு இன்றியமையாததாகும்.

இந்த ஆராய்ச்சியின் நோக்கம் குழந்தைகளிடையே கற்றல் குறைபாட்டை கண்டறியும் ஒரு கருவியைக் கண்டுபடிப்பதாகும். இந்த கருவியின் பயன் கண்டறியப்பட்டதும் இதனை உபயோகப்படுத்தி பலப்பல குழந்தைகளிடம் உள்ள கற்றல் குறைபாடுகளைக் கண்டறிந்து அவர்களுக்கு உதவ முடியும். இந்த படிவத்தை கவனமாகப் படிக்கவும் அல்லது இதில் உள்ள தகவல்களை உங்களுக்கு விளக்கமாக சொல்பவரை கவனிக்கவும். இதில் ஏதாவது ஒரு பகுதியோ, வார்த்தையோ தங்களுக்கு புரியாவிடில் கேள்வி கேட்டு விளக்கம் பெறவும். இந்த ஆராய்ச்சியில் தாங்கள் பங்கு கொள்வது முற்றிலும் சுய விருப்பத்தின் பேரிலேயே இருக்கும். இந்த ஆராய்ச்சியின் விவரங்கள் தங்களுக்கு விளக்கப்பட்டது, சந்தேகங்கள் தீர்த்து வைக்கப்பட்டன என்றால் தங்களுக்கு இதில் பங்குபெற விருப்பம் என்று இந்த படிவத்தில் கையொப்பம் இடவேண்டும்.
இந்த ஆராய்ச்சி வேலூர் கிறித்துவ மருத்துவக் கல்லூரியால் நடத்தப்படுகிறது.

ஆராய்ச்சி செயல்முறைகள்:

இந்த ஆராய்ச்சி 8 மாதங்கள் நடைபெறும். மொத்தம் 300 குழந்தைகள் பங்குபெறுவார்கள். குழந்தைகளின் பங்கு 4 மாதங்களுக்கு மட்டுமே தேவைப்படும். இந்த ஆராய்ச்சியில் பங்குபெறும் முன் தங்கள் மகன் / மகளின் IQ (அறிவாற்றல்) பரிசோதிக்கப்பட்டு, ஆராய்ச்சியில் பங்குபெறும் தகுதி பெற்றவரா என்று அறியப்படும். இந்த பரிசோதனையில் தேர்ந்தபின் புதிய கற்றல் குறைபாட்டை கண்டறியும் கருவி குழந்தையின் பள்ளியிலேயே அவர்களுக்கு அளிக்கப்படும். இதன்பின் மருத்துவர் மற்றும் மனோவியல் நிபுணர்கள் குழந்தையைப் பரிசோதித்து, கற்றல் குறைபாடு உள்ளதா என்று கண்டறிவர்.

இவை அனைத்தும் இலவசமாகச் செய்யப்படும். பரிசோதனை முடிவுகளை மருத்துவர்கள் மற்றும் சமூக சேவகர்கள் உங்களுக்கு எடுத்துக் கூறுவார்கள். அப்படி தங்கள் குழந்தைக்குக் கற்றல் குறைபாடு உள்ளது என்று அறியப்பட்டால் அதற்கு என்ன செய்யவேண்டும், மேற்கொண்டு செய்யவேண்டிய சிகிச்சை மற்றும் கல்வி பற்றியும் தெரிவிக்கப்படும். உங்கள் குழந்தையின் பரிசோதனை முடிவால் பள்ளிக் கல்வியில் எந்தவித மாற்றமும் ஏற்படாது. எந்த காரணத்தாலும் எந்த கட்டத்திலும் ஆராய்ச்சியிலிருந்து தங்கள் குழந்தையை தாங்கள் விலக்கிக் கொள்ளலாம். ஆராய்ச்சியிலிருந்து விலக்கிக்கொண்டாரோ பங்குகொள்ள மறுத்தாலோ தங்கள் குழந்தைக்கு எந்த வித பாதிப்பும் நேராது.

அபாயங்கள்:

இந்த ஆராய்ச்சியில் பங்கு கொள்வதால் தங்கள் குழந்தைக்கு எதிர்பார்க்கும் விதத்தில் எந்த ஒரு அபாயமும் ஏற்படாது.

நன்மைகள்:

தங்கள் குழந்தைக்கு அளிக்கப்படும் அத்தனை பரிசோதனைகளின் முடிவுகளும் தங்களுக்கு அறிவிக்கப்படும். தங்கள் குழந்தையின் IQ (அறிவாற்றல்) குறைவாக இருந்தாலோ, கற்றல் குறைபாடுகள் இருந்தாலோ கிறித்துவ மருத்துவ கல்லூரியின் குழந்தை மற்றும் வளர் இளம்பவத்தார் மனநலப் பிரிவில் அவர்களுக்கு சிகிச்சை மற்றும் ஆலோசனை அளிக்கப்படும். இது இலவசமாக அளிக்கப்படும். ஆனால் இது தொடர்பான சிகிச்சை தவிற மற்றபடி ஏற்படும் மேல் சிகிச்சைக்கான செலவு தங்களால் மேற்கொள்ளப்பட வேண்டும்.

ரகசியங்கள் பாதுகாப்பது:

தங்கள் குழந்தையிடமிருந்து சேகரிக்கப்படும் விஷயங்கள் ஒரு தனிப்பட்ட அடையாள எண்ணில் சேகரிக்கப்படும். எந்த ஆராய்ச்சிப் படிவத்திலும் தங்கள் குழந்தையின் பெயர் மற்றும் தனிநபர் அடையாளங்கள் வெளிப்படுத்தப்படமாட்டாது. தங்கள் குழந்தையின் பெயருக்குப் பொருந்தும் தனிப்பட்ட அடையாள எண் உள்ள கோப்பு ஆராய்ச்சியாளர்கள் மட்டும் தெரிந்துகொள்ளும் வகையில் பாதுகாக்கப்படும். இந்த ஆராய்ச்சியின் முடிவில் வெளியிடப்படும் எந்தவித குறிப்பிலும் தங்கள் குழந்தையின் தனிநபர் அடையாளம் இடம்பெறாது. இந்த ஆராய்ச்சி சம்மந்தமான தங்கள் குழந்தையின் குறிப்பேடுக்ள இந்திய மருத்துவ ஆராய்ச்சி குழுமம் (ICMR) மற்றும் கிறித்துவ மருத்துவக் கல்லூரியின் எதிக்ஸ் குழுமம் ஆகியவை கண்டறியலாம்.

முக்கியமான தொலைபேசி எண்கள்:

தங்களுக்கு ஆராய்ச்சி சம்மந்தமான எந்தவித சந்தேகமும் ஏற்பட்டால் தாங்கள் தொடர்புகொள்ள வேண்டிய தொலைபேசி எண்கள்:

மருத்துவர்.தான்யா சேஷாத்ரி – 9442379303

திருமதி. கி:.ப்டா மனோகரி – 9894093065

செலவு கணக்கு:

இந்த ஆராய்ச்சியின் செலவு வேலூர் கிறித்துவ மருத்துவக் கல்லூரி மேற்கொள்கிறது.

ஈடுதொகை:

தங்கள் குழந்தைக்கோ தங்களுக்கோ இந்த ஆராய்ச்சியில் பங்குபெறுவதற்காக எந்த வித ஈடுதொகையோ சன்மானமோ அளிக்கப்படமாட்டாது. தங்கள் குழந்தையைக் காண ஆராய்ச்சியாளர்கள் தங்கள் வீட்டிற்கோ அல்லது பள்ளிக்கோ வரப்போவதால் மற்ற வேறு எந்தவிதமான செலவும் தங்களுக்கு ஏற்பட வாய்ப்பில்லை. தாங்கள் குழந்தை மற்றும் வளர் இளம்பருவத்தார் மனநலப் பிரிவிற்கு மருத்துவமனைக்கு அழைக்கப்பட்டால் அதற்கு ஏற்படும் போக்குவரத்து செலவு தங்களுக்கு அளிக்கப்படும்.

பங்கு பெறுபவரின் ஒப்புதல்:

இந்த ஒப்புதல் படிவத்தை நான் படித்துவிட்டேன் அல்லது வாசிக்கக்கேட்டேன். மருத்துவர் தான்யா செஷாத்ரி மற்றும் அவரின் பிரதிநிதி ஆராய்ச்சி முறைகளை எனக்கு விவரித்துவிட்டார். கேள்விகள் கேட்டு சந்தேகங்களை தீர்த்துக்கொள்ள எனக்கு அவகாசம் திருப்திகரமாக அளிக்கப்பட்டது. என் சந்தேகங்கள் தீர்த்துவைக்கப்பட்டன.

என் குழந்தையின் நிலை பற்றிய முடிவுகள் பரிசோதனை முடிவின்போது எனக்கு அறிவிக்கப்படும் என்று அறிகிறேன்.

இந்த ஆராய்ச்சியில் பங்குபெறுவது என் சுய விருப்பத்தின் பேரிலேயே உள்ளது. நானோ அல்லது என் குழந்தை மறுத்தாலோ எந்த கட்டத்திலும் ஆராய்ச்சியிலிருந்து விலகிக்கொள்ளலாம். மறுத்தாலோ அல்லது விலகிக்கொண்டாலோ அதனால் எந்த வித தீய விளைவுகளும் நேராது என்று அறிகிறேன்.
இந்த ஆராய்ச்சியின் நன்மை தீமைகளைப் புரிந்துகொண்டு ஒப்புதல் அளிக்கிறேன். இந்த படிவத்தின் கையொப்பமிட்ட நகல் எனக்கு அளிக்கப்பட்டது.

இந்த ஆராய்ச்சியில் பங்கெடுக்கும் ஒருவரான என் குழந்தையின் தனிப்பட்ட அடையாளம் மற்றும் கோப்புகள், தகவல்கள் இந்த ஆராய்ச்சியில் ரகசியமாக பாதுகாக்கப்படும் என்பதும் தேவைப்பட்டால் சட்ட விதிமுறைக்கோ, (மானுடம் பாதுகாக்கும்) எதிக்ஸ் குழு உறுப்பினர்களோ, வரைமுறைப்படுத்தும் நிறுவனமோ, நிதியுதவி செய்பவரோ காணலாம் என்பதையும் அறிந்துகொண்டேன்.

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பெற்றோர் சட்ட பாதுகாப்பாளர் தேதி
(கையெப்பம்/பெருவிரல் ரேகை)

ABSTRACT

Background India has made great progress in expanding the formal schooling system and in improving enrolments in the primary school. However, the focus needs to shift from equity in access to equity in achievement. Learning Disability is an important factor that affects a child's academic potential and has been estimated to have a high prevalence of 5 – 18% globally.

Methods The first step involved development of the screening tool for SLD which was done with the aid of school teachers and child psychiatrists. The final screening tool created had 3 sections – Reading, Writing and Mathematics with a total of 21 items. The study subjects were 259 children who had finished second grade in 11 randomly selected Elementary and Aided Government schools in Kaniyambadi block, Vellore. Children with an IQ < 70 were excluded. The screening tool was then applied to the 233 children who were eligible. 78 children were selected based on their scores from the test and were subjected to the DSM IV-TR criteria which was the reference standard. The results were used to validate the screening tool. The cut-off score arrived at was applied to all 259 children and the prevalence of learning disability was estimated in the study population.

Results The screening tool created was found to have a sensitivity of 80.6% and a specificity of 85.1% at a cut-off score of 43.5. Of the 78 children, 31.2% were found to have some learning disability. 10.3% had reading disability and 9% had writing disability in Tamil while only 5.1% had a problem in mathematics. The prevalence of learning disability in the study subjects was found to be 24.8%.

Conclusions A simple and easy to apply screening tool was created which will be able to screen children at an early stage in Elementary schools. It will not only detect children with specific learning disability but also be able to identify children with mental retardation and other disabilities. Also a significant proportion of children had a disability involving the Tamil language. This indicates the need for further research into language disabilities especially in a diverse country like India.